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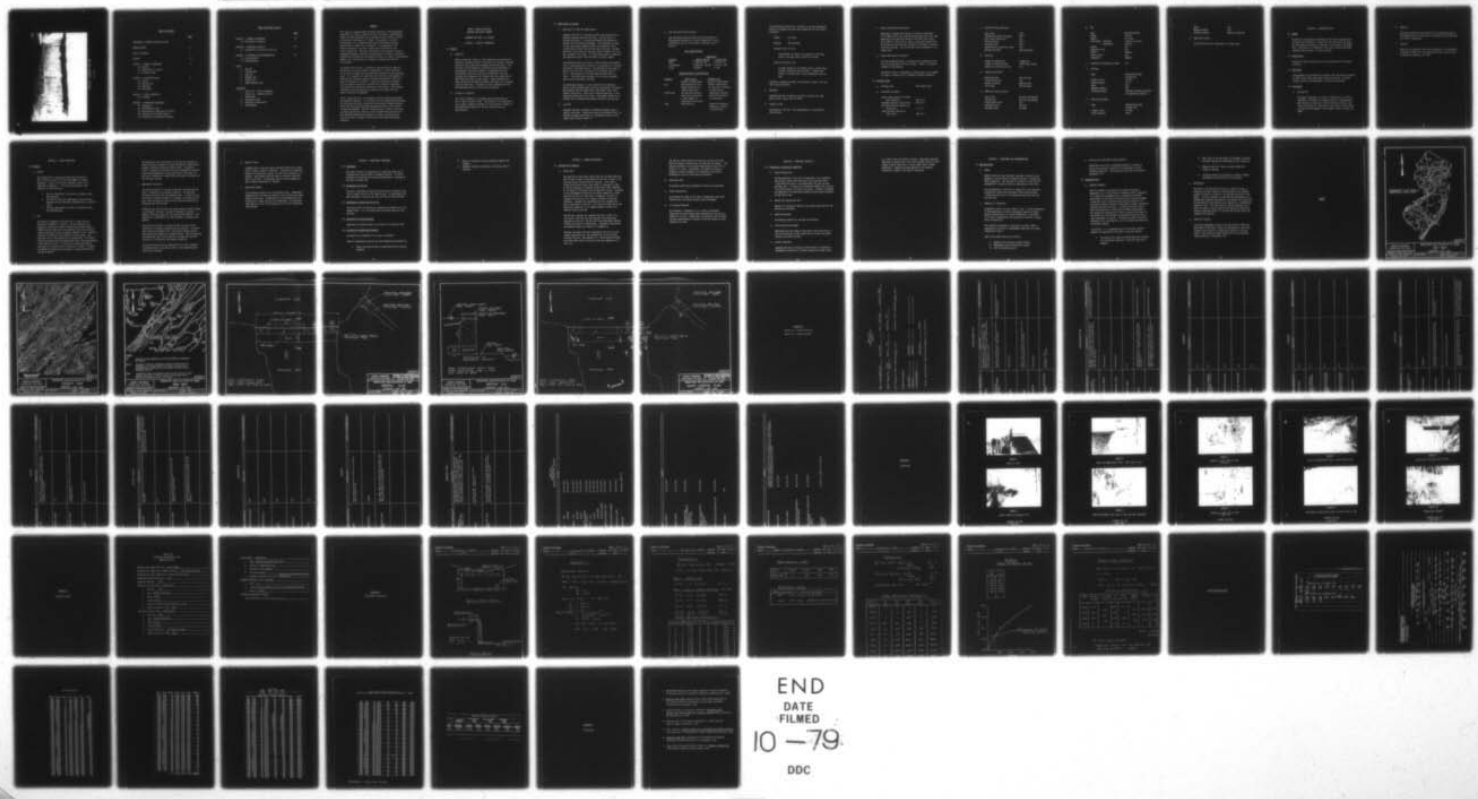

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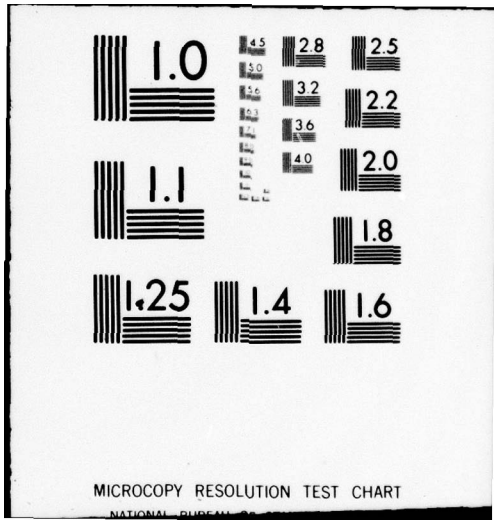
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LEVEL II

PASSAIC RIVER BASIN
ROCKAWAY RIVER, MORRIS COUNTY
NEW JERSEY

LONGWOOD LAKE DAM
NJ 00333

PHASE 1 INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

Longwood Lake Dam (NJ-00333). Passaic River Basin. Rockaway River, Morris County, New Jersey.
Phase 1 Inspection Report.

(9) Final rept.,

(15) DACW61-79-C-0011

(10) Richard J. McDermott
John E. Gribbin

(12) 88

DEPARTMENT OF THE ARMY
Philadelphia District
Corps of Engineers
Philadelphia, Pennsylvania

(11) Aug 79

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Longwood Lake Dam, N.J.
Seepage
Outlet Works
Dams
Structural Analysis
Visual inspection
National Dam Inspection Act Report

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report cites results of a technical investigation as to the dam's adequacy. The inspection and evaluation of the dam is as prescribed by the National Dam Inspection Act, Public Law 92-367. The technical investigation includes visual inspection, review of available design and construction records, and preliminary structural and hydraulic and hydrologic calculations, as applicable. An assessment of the dam's general condition is included in the report.

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DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
CUSTOM HOUSE—2D & CHESTNUT STREETS
PHILADELPHIA, PENNSYLVANIA 19106

IN REPLY REFER TO

NAPEN-D

25 SEP 1979

Honorable Brendan T. Byrne
Governor of New Jersey
Trenton, NJ 08621

Dear Governor Byrne:

Inclosed is the Phase I Inspection Report for Longwood Lake Dam in Morris County, New Jersey which has been prepared under authorization of the Dam Inspection Act, Public Law 92-367. A brief assessment of the dam's condition is given in the front of the report.

Based on visual inspection, available records, calculations and past operational performance, Longwood Lake Dam, initially listed as a high hazard potential structure, but reduced to a low hazard potential structure as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate since 12 percent of the One Hundred Year Flood would overtop the dam. The low hazard classification means that in the event of failure of the dam, no loss of life and only minimal economic loss is expected. To insure the continued functioning of the dam and its impoundment, the following remedial actions could be undertaken:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies. This should include analyses relating to the height of water overtopping the dam under SDF conditions. A stability analysis should then be performed to evaluate the effect on the stability of the dam due to overtopping resulting from a storm equivalent to the SDF. The analysis should include all necessary field investigations, such as borings and monitoring of observed seepage.

b. The outlet works should be investigated and restored to a functional condition so that the lake can be lowered.

c. Both faces of the dam should be thoroughly inspected and then renovated as determined by that inspection.

d. Measures should be taken to prevent pedestrian access to the dam.

e. A barrier should be constructed to prevent swimmers and boaters from passing over the spillway.

f. The owner of the dam should initiate a program of periodic inspection and maintenance, the complete records of which should be kept on file. A visual inspection of the dam and appurtenances should be made annually and reported on a standardized check-list form. The lake should be lowered completely once every five years at which time the lake should be cleaned and normally submerged portions of the dam and spillway should be inspected and repaired.

g. A detailed topographic survey of the dam and area around the dam, based on USGS datum, should be made. The survey map should become part of the permanent record.

A copy of the report is being furnished to Mr. Dirk C. Hofman, New Jersey Department of Environmental Protection, the designated State Office contact for this program. Within five days of the date of this letter, a copy will also be sent to Congressman James A. Courter of the Thirteenth District. Under the provision of the Freedom of Information Act, the inspection report will be subject to release by this office, upon request, five days after the date of this letter.

Additional copies of this report may be obtained from the National Technical Information Services (NTIS), Springfield, Virginia 22161 at a reasonable cost. Please allow four to six weeks from the date of this letter for NTIS to have copies of the report available.

NAPEN-D
Honorable Brendan T. Byrne

An important aspect of the Dam Safety Program will be the implementation of the recommendations made as a result of the inspection. We accordingly request that we be advised of proposed actions taken by the State to implement our recommendations.

Sincerely,

James G. Ton

1 Incl
As stated

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

Copies furnished:
Mr. Dirk C. Hofman, P.E., Deputy Director
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

Mr. John O'Dowd, Acting Chief
Bureau of Flood Plain Management
Division of Water Resources
N.J. Dept. of Environmental Protection
P.O. Box CN029
Trenton, NJ 08625

LONGWOOD LAKE DAM (NJ00333)

CORPS OF ENGINEERS ASSESSMENT OF GENERAL CONDITIONS

This dam was inspected on 1 May and 6 June 1979 by Storch Engineers under contract to the State of New Jersey. The State, under agreement with the U.S. Army Engineer District, Philadelphia, had this inspection performed in accordance with the National Dam Inspection Act, Public Law 92-367.

Longwood Lake Dam, initially listed as a high hazard potential structure, but reduced to a low hazard potential structure as a result of this inspection, is judged to be in fair overall condition. The dam's spillway is considered inadequate since 12 percent of the One Hundred Year Flood would overtop the dam. The low hazard classification means that in the event of failure of the dam, no loss of life and only minimal economic loss is expected. To insure the continued functioning of the dam and its impoundment, the following remedial actions could be undertaken:

a. The spillway's adequacy should be determined by a qualified professional consultant engaged by the owner using more sophisticated methods, procedures, and studies. This should include analyses relating to the height of water overtopping the dam under SDF conditions. A stability analysis should then be performed to evaluate the effect on the stability of the dam due to overtopping resulting from a storm equivalent to the SDF. The analysis should include all necessary field investigations, such as borings and monitoring of observed seepage.

b. The outlet works should be investigated and restored to a functional condition so that the lake can be lowered.

c. Both faces of the dam should be thoroughly inspected and then renovated as determined by that inspection.

d. Measures should be taken to prevent pedestrian access to the dam.

e. A barrier should be constructed to prevent swimmers and boaters from passing over the spillway.

f. The owner of the dam should initiate a program of periodic inspection and maintenance, the complete records of which should be kept on file. A visual inspection of the dam and appurtenances should be made annually and reported on a standardized check-list form. The lake should be lowered completely once every five years at which time the lake should be cleaned and normally submerged portions of the dam and spillway should be inspected and repaired.

g. A detailed topographic survey of the dam and area around the dam, based on USGS datum, should be made. The survey map should become part of the permanent record.

APPROVED: James G. Ton

JAMES G. TON
Colonel, Corps of Engineers
District Engineer

DATE: 22 Sep 1979

PHASE I REPORT
NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Longwood Lake Dam, I.D.NJ00333
State Located:	New Jersey
County Located:	Morris
Drainage Basin:	Passaic River
Stream:	Rockaway River
Date of Inspection:	May 1, 1979 and June 6, 1979

Assessment of General Condition of Dam

Based on visual inspection and Phase I engineering analyses, the dam is assessed as being in fair overall condition.

Based on investigations of the downstream flood plain made in connection with this report, it is recommended that the hazard potential classification be downgraded from high to low hazard.

Hydraulic and hydrologic analyses indicate that the spillway is not adequate to pass the designated spillway design flood (100-year storm) without an overtopping of the dam. The spillway is capable of passing approximately 11 percent of the SDF. It is therefore recommended that a professional engineer experienced in the design and construction of dams be engaged in the near future to perform more accurate hydraulic and hydrologic analyses relating to the height of water overtopping the dam under SDF conditions. A stability analysis should then be performed by a professional engineer experienced in the design and construction of dams to evaluate the effect on the stability of the dam due to overtopping resulting from a storm equivalent to the SDF. The analysis should include all necessary field investigations, such as borings and monitoring of observed seepage.

In addition, it is recommended that the following remedial measures be undertaken by the owner in the near future:

1. The outlet works should be investigated and restored to a functional condition so that the lake can be lowered.

2. Both faces of the dam should be thoroughly inspected and then renovated as determined by that inspection.

3. Measures should be taken to prevent pedestrian access to the dam.

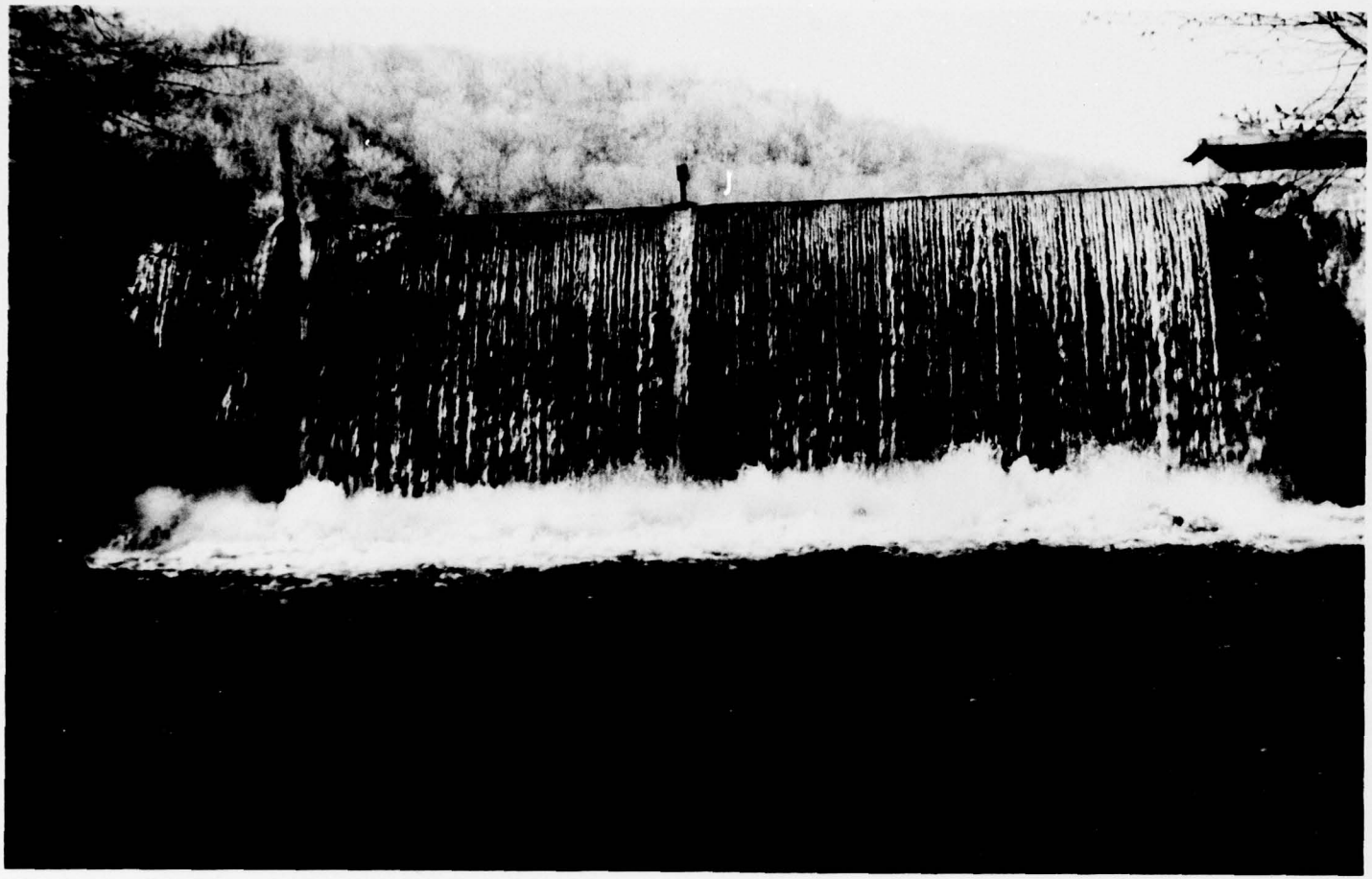
4. A barrier should be constructed to prevent swimmers and boaters from passing over the spillway.

The owner of the dam should initiate, in the near future, a program of periodic inspection and maintenance, the complete records of which to be kept on file and made available to the public. A visual inspection of the dam and appurtenances by a professional engineer experienced in the design and construction of dams should be made annually and reported on a standardized check-list form. The lake should be lowered completely once every five years at which time the lake should be cleaned and normally submerged portions of the dam and spillway should be inspected and repaired.

A detailed topographic survey of the dam and area around the dam, based on the USGS datum, should be undertaken by a qualified licensed land surveyor or professional engineer in the near future. The survey map should become part of the permanent record mentioned above.

Richard J. McDermott, P.E.

John E. Gribbin, P.E.



OVERVIEW - LONGWOOD LAKE DAM

1 MAY 1979

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PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 30214. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. It is important to note that the condition of dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that the unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. The test flood provides a measure of relative spillway capacity and serves as an aid in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

LONGWOOD LAKE DAM, I.D. NJ00333

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

Public Law 92-367, August 8, 1972 authorized the Secretary of the Army, through the Corps of Engineers to initiate a National Program of Dam Inspection throughout the United States. The Division of Water Resources of the New Jersey Department of Environmental Protection (NJDEP) in cooperation with the Philadelphia District of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the State of New Jersey. Storch Engineers has been retained by the NJDEP to inspect and report on a selected group of these dams. The NJDEP is under agreement with the Philadelphia District of the Corps of Engineers.

b. Purpose of Inspection

The visual inspections of Longwood Lake Dam were made on May 1, 1979 and June 6, 1979. The purpose of the inspections was to make a general assessment of the structural integrity and operational adequacy of the dam structure and its appurtenances.

1.2 Description of Project

a. Description of Dam and Appurtenances

Longwood Lake Dam is a straight concrete overflow dam with a separate concrete auxiliary spillway. The dam, which is oriented east-west, is constructed between outcroppings of bedrock that form natural abutments. The auxiliary spillway is also constructed between natural rock abutments and is located about 40 feet from the east end of the dam. The dam which has a top width of 6 feet and overall length of 91 feet, has a height of 18.4 feet. A 12-foot wide apron is located on the downstream side of the dam along its entire length.

The downstream face of the dam is vertical while the upstream face is constructed with a batter of 1 horizontal to 4 vertical according to the NJDEP record. The elevation of the crest of dam is 739.5 (N.G.V.D.) and that of the spillway crest is 737.1. The elevation of the auxiliary spillway crest is 739.2. The outlet works consists of a 42-inch corrugated metal pipe at the base of the dam.

The downstream channel is a well defined river (Rockaway River) flowing between nearly vertical outcroppings of bedrock. Approximately 250 feet downstream, the channel flows into a broader flood plain. There are no observed dwellings in the downstream flood plain for 2 miles. One timber bridge for an unpaved road is located approximately 250 feet from the dam.

b. Location

Longwood Lake Dam is located in Jefferson Township, Morris County, New Jersey. Constructed across the Rockaway River, it impounds Longwood Lake which is a recreational facility for summer homes located around it.

c. Size and Hazard Classification

Size and Hazard Classification criteria presented in "Recommended Guidelines for Safety Inspection of Dams", published by the U.S. Army Corps of Engineers are as follows:

SIZE CLASSIFICATION

	Impoundment	
Category	Storage (Ac-ft)	Height (Ft)
Small	< 1000 and ≥ 50	< 40 and ≥ 25
Intermediate	≥ 1000 and < 50,000	≥ 40 and < 100
Large	≥ 50,000	≥ 100

HAZARD POTENTIAL CLASSIFICATION

Category	Loss of Life (Extent of Development)	Economic Loss (Extent of Development)
Low	None expected (no permanent structures for human habitation)	Minimal (Undeveloped to occasional structures or agriculture)
Significant	Few (No urban developments and no more than a small number of inhabitable structures)	Appreciable (Notable agriculture, industry or structures)
High	More than few	Excessive (Extensive community, industry or agriculture)

The following characteristics relating to size and downstream hazard for Longwood Lake have been determined for this Phase I assessment:

Height: 21.5 feet

Storage: 351 Acre-feet

Potential Loss of Life:

No dwellings are known to be located in the flood plain of the dam within 2 miles of the dam.

Potential Economic Loss:

A timber bridge for an unpaved road is located about 250 feet downstream from the dam. A county road bridge is located about 2 miles downstream from the dam.

Therefore, Longwood Lake Dam is classified as "Small" size and "Low" hazard potential.

d. Ownership

Longwood Lake Dam is owned by the City of Jersey City, 280 Grove Street, Jersey City, NJ 07302.

e. Purpose of Dam

The purpose of the dam is the impoundment of a recreational lake facility.

f. Design and Construction History

Reportedly, Longwood Lake Dam was originally constructed circa 1898 and has been essentially unchanged since that time. Reportedly, the lake was lowered for the last time in the early 1950's at which time a timber sluice gate located east of the dam was replaced with concrete to form what is now the auxiliary spillway. The 42-inch CMP outlet reportedly is no longer used.

g. Normal Operational Procedures

The dam and appurtenances are operated and maintained by the City of Jersey City, Division of Water. There is no regular schedule of maintenance.

The outlet, which is reportedly no longer used, is not opened at times of intense rain to attenuate flooding conditions.

1.3 Pertinent Data

a. Drainage Area	19.0 square miles
b. Discharge at Damsite	
Outlet works capacity at normal pool elevation	813 c.f.s.
Spillway capacity at top of dam	572 c.f.s.
Auxiliary spillway capacity at top of dam	5 c.f.s.
Total spillway capacity at top of dam	577 c.f.s.

c. Elevation (Feet above MSL)

Top of dam	739.5
Maximum pool-design surcharge	744.7
Full flood control pool	N.A.
Recreation pool	737.4
Spillway crest	737.1
Stream bed at centerline of dam	718
Maximum tailwater	728 (Estimated)

d. Reservoir

Length of maximum pool	10,000 feet
Length of recreation pool	7,000 feet (scaled)
Length of flood control pool	N.A.

e. Storage (Acre-feet)

Recreation pool	214 acre-feet
Flood control pool	N.A.
Design surcharge	969 acre-feet
Top of dam	351 acre-feet

f. Reservoir Surface (Acres)

Top of dam	56 acres (Estimated)
Maximum pool	82 acres (Estimated)
Flood control pool	N.A.
Recreation pool	43 acres
Spillway crest	43 acres

g. Dam

Type	Concrete Gravity
Length	91 feet
Height	21.5 feet
Side slopes - Upstream	1 horiz. to 4 vert.
- Downstream	Vertical
Zoning	N.A.
Impervious core	N.A.
Cutoff	Unknown
Grout curtain	N.A.
Foundation	Unknown

h. Diversion and Regulating Tunnel — N.A.

i. Spillway

Type	Uncontrolled broad crested weir
Length of weir	51 feet
Crest elevation	737.1
Gates	N.A.
Approach channel	N.A.
Discharge channel	Spillway discharges directly into downstream channel

j. Auxiliary Spillway

Type	Uncontrolled broad crested weir
Length of weir	11 feet
Crest elevation	739.2

Gates	N.A.
Approach channel	N.A.
Discharge channel	Natural stream bed

k. Regulating outlets

42-inch CMP with gate (reportedly, no longer used)

SECTION 2: ENGINEERING DATA

2.1 Design

No plans nor calculations pertaining to the original construction of the dam are available. A profile of the river above and below the dam, showing elevations of the dam, is contained in the NJDEP file. Reference to an inspection of the dam in 1978 by the NJDEP indicates that the dam is in need of repair.

2.2 Construction

No data nor reports pertaining to the construction of the dam are available.

2.3 Operations

Correspondence in the NJDEP file indicates that the lake was lowered in 1939 to facilitate weed removal around the shores. No other written records of the operation of the dam are available.

2.4 Evaluation

a. Availability

Available information is limited to that which is on file at the NJDEP. The NJDEP file contains copies of correspondence and a profile of the river in the vicinity of the dam. The file is available for inspection at the offices of the Bureau of Flood Plain Management, 1474 Prospect Street, Trenton, N.J. 08625.

b. Adequacy

Available engineering data pertaining to Longwood Lake Dam is not adequate to be of significant assistance to the performance of a Phase I evaluation.

c. Validity

Based on the findings of the field inspection, the information contained in NJDEP file for Longwood Lake Dam is valid within a reasonable allowance for error.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

The inspections of Longwood Lake Dam were performed on May 1, 1979 and June 6, 1979 by staff members of Storch Engineers. A copy of the visual inspection check list is contained in Appendix 1. The following procedures were employed for the inpsection:

1. The dam, appurtenant structures and adjacent areas were examined.
2. The dam and accessible appurtenant structures were measured and key elevations determined by a surveyor's level.
3. The dam, appurtenant structures and adjacent areas were photographed.

b. Dam

The vertical alignment of the dam crest is level and the horizontal alignment is straight. The dam appeared to be outwardly structurally stable, although some spalling about 3 inches deep was observed on the downstream face near each end. Junctions between the dam and bedrock appeared to be in generally satisfactory condition with evidence of some seepage. The discharge rate of the seepage was not measurable. A horizontal crack was observed along the downstream face of dam approximately 1 foot below the crest. It could not be determined whether the crack is on the surface or structural in nature. Evidence of leakage was observed at some seams in exposed bedrock near the east junction.

The generalized soil description of the dam site consists of recent alluvium, composed of stratified materials deposited by streams, overlying stratified glacial drift. The glacial drift is composed of assorted, relatively homogeneous materials consisting predominantly of sand and gravel, with some silt and clay in depressions, deposited by melt-waters flowing from the Wisconsin glacier.

c. Appurtenant Structures

The overflow section of the dam forming the spillway appeared to be in generally satisfactory condition. The spillway discharges directly into the Rockaway River. A group of rocks serving as an energy dissipator is located on the apron of the dam. Both the group of rocks and the apron were obscured by discharge over the spillway.

Discharge over the spillway falls freely onto the rocks located on the apron of the dam. No barrier designed to prevent objects from being swept over the spillway was observed. This condition is considered to be very hazardous to swimmers and boaters.

The auxiliary spillway is located 40 feet from the dam and consists of a straight concrete broad crested weir. Flow over this spillway discharges into a narrow well defined channel with steep sides composed of exposed bedrock. Both the upstream and downstream faces of the auxiliary spillway are vertical. The crest is in generally satisfactory condition.

The 42-inch outlet pipe was observed to be in fair condition. The upstream end of the pipe as well as the regulating gate could not be observed.

d. Reservoir Area

Longwood Lake is long and narrow, averaging 300 feet in width, with an overall length of 7000 feet. Its shores are generally wooded with steep banks ranging in slope from 5 percent to 20 percent. Many summer homes and docks are located along the banks of the lake. The upstream side of the dam appeared to have a heavy accumulation of sediment.

e. Downstream Channel

The spillways discharge into the Rockaway River. Immediately downstream from the dam the channel is well defined with steep bedrock lined banks. Approximately 250 feet downstream, the flood plain is wider and has less steep banks. No structures were observed to be in the flood plain for 2 miles downstream from the dam.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

The level of water in Longwood Lake is regulated naturally by discharge over the spillways of Longwood Lake Dam. No formal procedure for operating the dam and appurtenances is employed by the City of Jersey City.

4.2 Maintenance of the Dam

The dam is reportedly maintained by the Division of Water of the City of Jersey City on an "as needed" basis. No maintenance has been performed in the one year that the City has owned the dam.

4.3 Maintenance of Operating Facilities

The outlet works for the dam are reportedly maintained on an "as needed" basis. It is not known when the outlet works was last serviced.

4.4 Description of Warning System

Reportedly no warning system is in effect at the present time.

4.5 Evaluation of Operational Adequacy

No record of the operation of the dam is available.

Areas of maintenance that have not been adequately performed are:

1. Spalls and deterioration on downstream face of dam not repaired.

2. Debris in auxiliary spillway discharge channel not removed.
3. Sediment allowed to accumulate at upstream side of spillway.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design Data

The quantity of storm water runoff that the spillway should be able to pass without an overtopping of the dam is based on the size and hazard classification of the dam. This runoff, called the spillway design flood (SDF) is described in terms of return frequency or probable maximum flood (PMF) depending on the extent of the dam's size and potential hazard. According to the "Recommended Guidelines for Safety Inspection of Dams" published by the U.S. Army Corps of Engineers, the SDF for Longwood Lake Dam falls in a range of 50-year to 100-year frequency. Although the characteristics for Longwood Lake Dam, as described in Section 1, fall into the lower end of the prescribed catagories, it is deemed prudent to select the 100-year storm as the SDF.

The SDF peak computed for Longwood Lake Dam is 5539 c.f.s. This value is derived from the 100-year flood hydrograph computed by the use of the HEC-1-DB Flood Hydrograph Computer Program using Snyder's coefficients. Hydrologic computations and computer output are contained in Appendix 4.

Spillway discharge rates were computed by the use of a weir formula appropriate for the configuration of the spillway overflow sections. (See Appendix 4.) The spillway discharge with lake level equal to the top of dam was computed to be 577 c.f.s.

The SDF was routed through the reservoir by the use of the HEC-1-DB computer program using the modified Puls method. The routing resulted in an estimated overtopping of the dam to a height of 5.2 feet. Accordingly, the subject spillway is assessed as being inadequate in accordance with criteria developed by the U.S. Army Corps of Engineers.

b. Experience Data

No records concerning overtopping of the dam are available.

c. Visual Observations

No evidence was found at the time of inspections that would indicate that the dam had recently been overtopped.

d. Overtopping Potential

As indicated in paragraph 5.1.a, a storm of magnitude equivalent to th SDF would cause overtopping of the dam to a height of 5.2 feet. Computations indicate that the spillways can pass approximately 11 percent of the SDF without an overtopping of the dam.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

The dam appeared, at the time of inspection, to be outwardly structurally stable with horizontal cracks observed about 1 foot below the crest in the downstream face near the east and west ends. It could not be determined whether the cracking is on the surface or structural in nature. Evidence of seepage was observed at the junctions between dam and natural abutments at each end of dam.

b. Design and construction data

Analysis of structural stability and construction data for the dam are not available.

c. Operating Records

No operating records for the dam are available.

d. Post Construction Changes

Reportedly the only change to the dam or area surrounding it was the elimination of the timber sluice to form the present concrete auxiliary spillway.

e. Seismic Stability

Longwood Lake Dam is located in Seismic Zone 1 as defined in "Recommended Guidelines for Safety Inspection of Dams" which

is a zone of very low seismic activity. Experience indicates that dams in Seismic Zone 1 will have adequate stability under seismic loading conditions if stable under static loading conditions. Longwood Lake Dam appeared to be outwardly structurally stable at the time of inspection.

SECTION 7: ASSESSMENT AND RECOMMENDATIONS

7.1 Dam Assessment

a. Safety

Based on hydraulic and hydrologic analyses in Section 5 and Appendix 4, the spillway of Longwood Lake Dam is assessed as being inadequate. The spillway is not able to pass the SDF designated for the dam without an overtopping of the crest.

The dam appeared, at the time of inspection, to be outwardly structurally stable with horizontal cracks observed about 1 foot below the crest in the downstream face near the east and west ends.

b. Adequacy of Information

Information sources for this study include: 1) field inspection, 2) USGS quadrangle, 3) Aerial photograph supplied by Morris County Planning Board, 4) limited information in the NJDEP file, and 5) consultation with personnel of Division of Water, City of Jersey City.

The information obtained is sufficient to allow a Phase I assessment as outlined in "Recommended Guidelines for Safety Inspection of Dams."

Some of the absent data are as follows:

1. Hydraulic and structural design reports.
2. Maintenance and lake elevation records.
3. Soils and geology report.

c. Necessity for Additional Data/Evaluation

Additional evaluation is considered necessary in order to assess the structural stability of the dam under various overflow conditions. The evaluation should be as outlined in paragraph 7.2.a.

7.2 Recommendations

a. Remedial Measures

Based on hydraulic and hydrologic analyses outlined in paragraph 5.1.a, the spillway is assessed as being inadequate. It is therefore recommended that a professional engineer experienced in the design and construction of dams be engaged in the near future to perform more accurate hydraulic and hydrologic analyses relating to the height of water overtopping the dam under SDF conditions. A stability analysis should then be performed by a professional engineer experienced in the design and construction of dams to evaluate the effect on the stability of the dam due to overtopping resulting from a storm equivalent to the SDF. The analysis should include all necessary field investigations, such as borings and monitoring of observed seepage.

In addition, it is recommended that the following remedial measures be undertaken by the owner in the near future:

1. The outlet works should be investigated and restored to a functional condition so that the lake can be lowered.

2. Both faces of the dam should be thoroughly inspected and then renovated as determined by that inspection.

3. Measures should be taken to prevent pedestrian access to the dam.

4. A barrier should be constructed to prevent swimmers and boaters from passing over the spillway.

b. Maintenance

The owner of the dam should initiate, in the near future, a program of periodic inspection and maintenance, the complete records of which to be kept on file and made available to the public. A visual inspection of the dam and appurtenances by a professional engineer experienced in the design and construction of dams should be made annually and reported on a standardized check-list form. The lake should be lowered completely once every five years at which time the lake should be cleaned and normally submerged portions of the dam and spillway should be inspected and repaired.

c. Additional Studies

A detailed topographic survey of the dam and area around the dam, based on USGS datum, should be undertaken by a qualified licensed land surveyor or professional engineer in the near future. The survey map should become part of the permanent record mentioned in paragraph 7.2.b.

PLATES

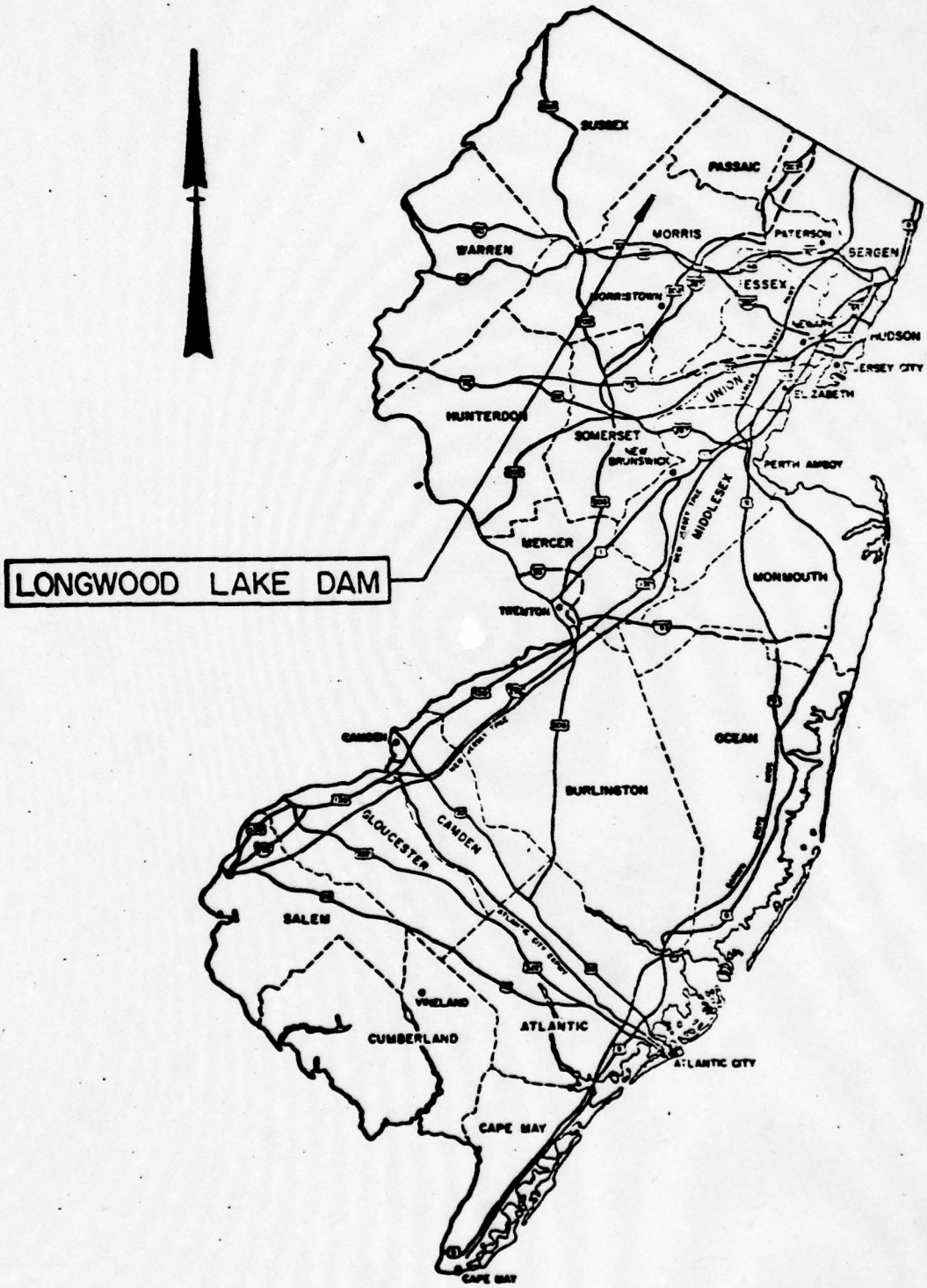


PLATE 1

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

KEY MAP

LONGWOOD LAKE DAM

I.D. NJ00333

SCALE: NOT TO SCALE

DATE: JUNE, 1979

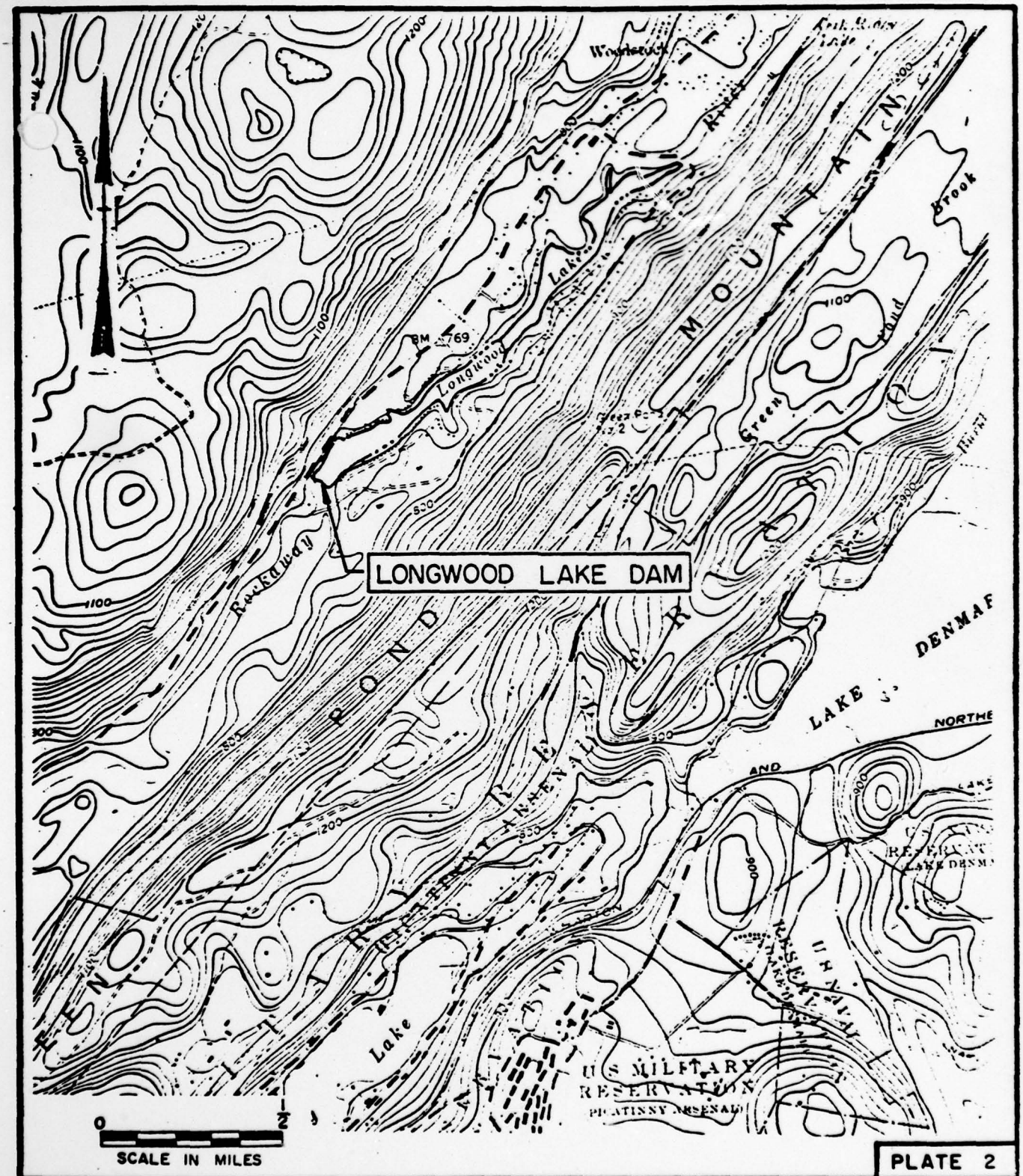


PLATE 2

STORCH ENGINEERS
FLORHAM PARK, NEW JERSEY

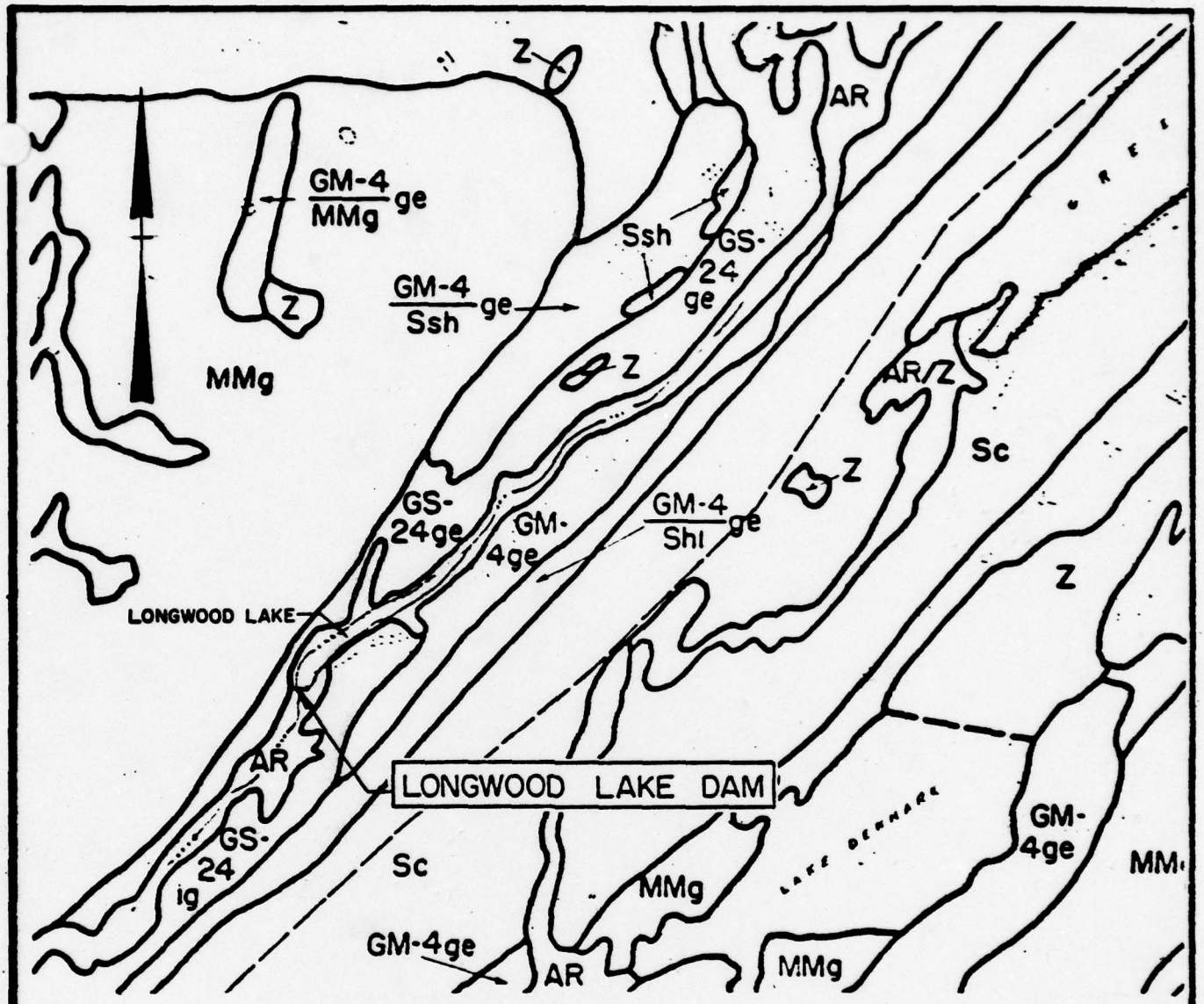
DIVISION OF WATER RESOURCES
N.J. DEPT. OF ENVIR. PROTECTION
TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

VICINITY MAP

LONGWOOD LAKE DAM

I.D. NJ00333	SCALE: AS SHOWN
	DATE: JUNE, 1979



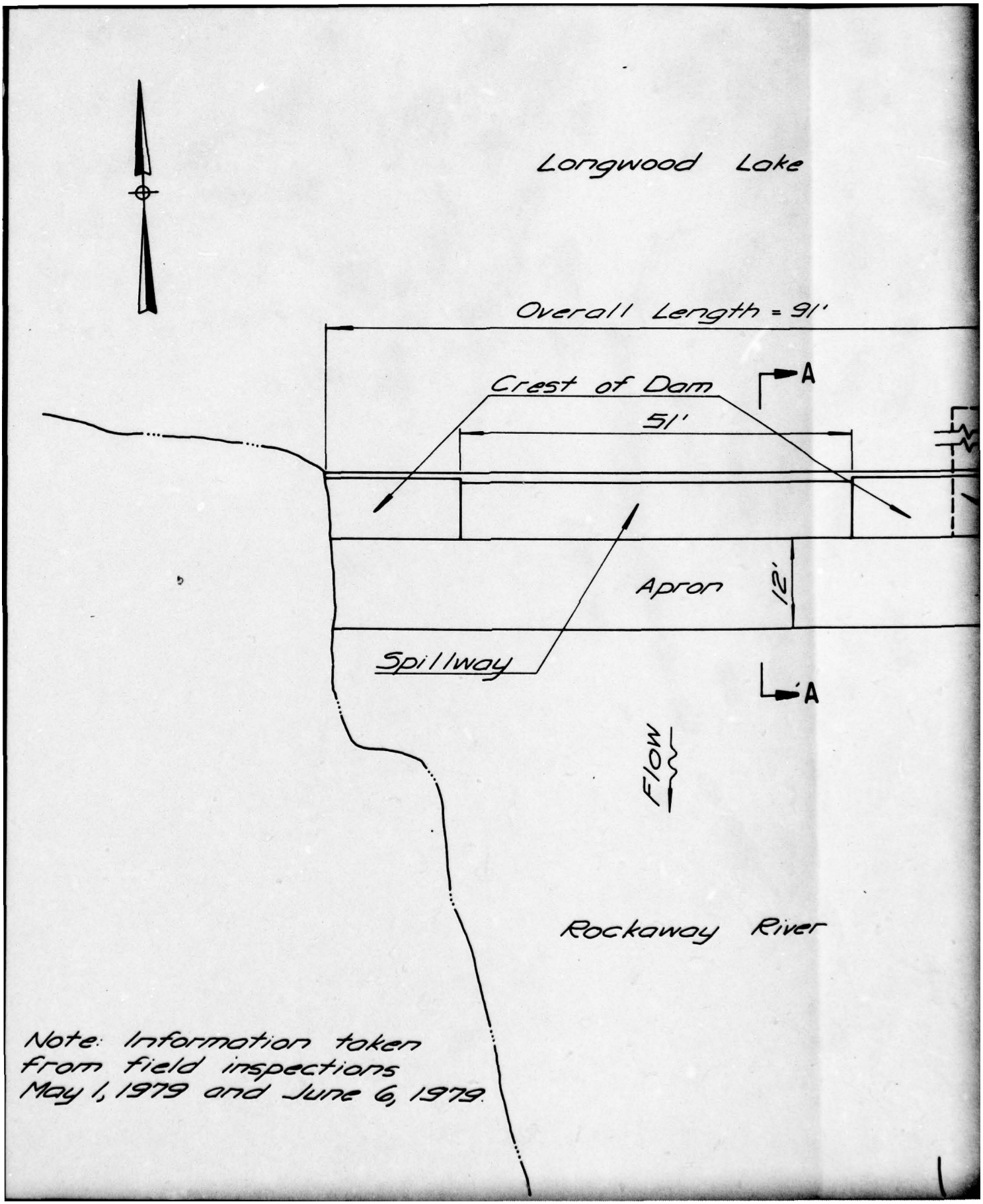
Legend

AR	Recent alluvium composed of stratified materials deposited by streams.
GS-24	Assorted, relatively homogeneous materials consisting predominantly of sand and gravel, with some silt and clay in depressions, deposited by melt-waters flowing from the Wisconsin glacier.

NOTE: Information taken from Rutgers University Soil Survey of New Jersey, Report No. 9, Morris County, and Geologic Map of New Jersey prepared by Lewis and Kummel.

PLATE 3

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS **SOIL MAP** LONGWOOD LAKE DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D. NJ 00 333 — SCALE: NONE DATE: JULY, 1979


Longwood Lake
Overall Length = 91'
Crest of Dam
A
51'
Apron
12'
Spillway
A
Flow
Rockaway River
Note: Information taken from field inspections May 1, 1979 and June 6, 1979.

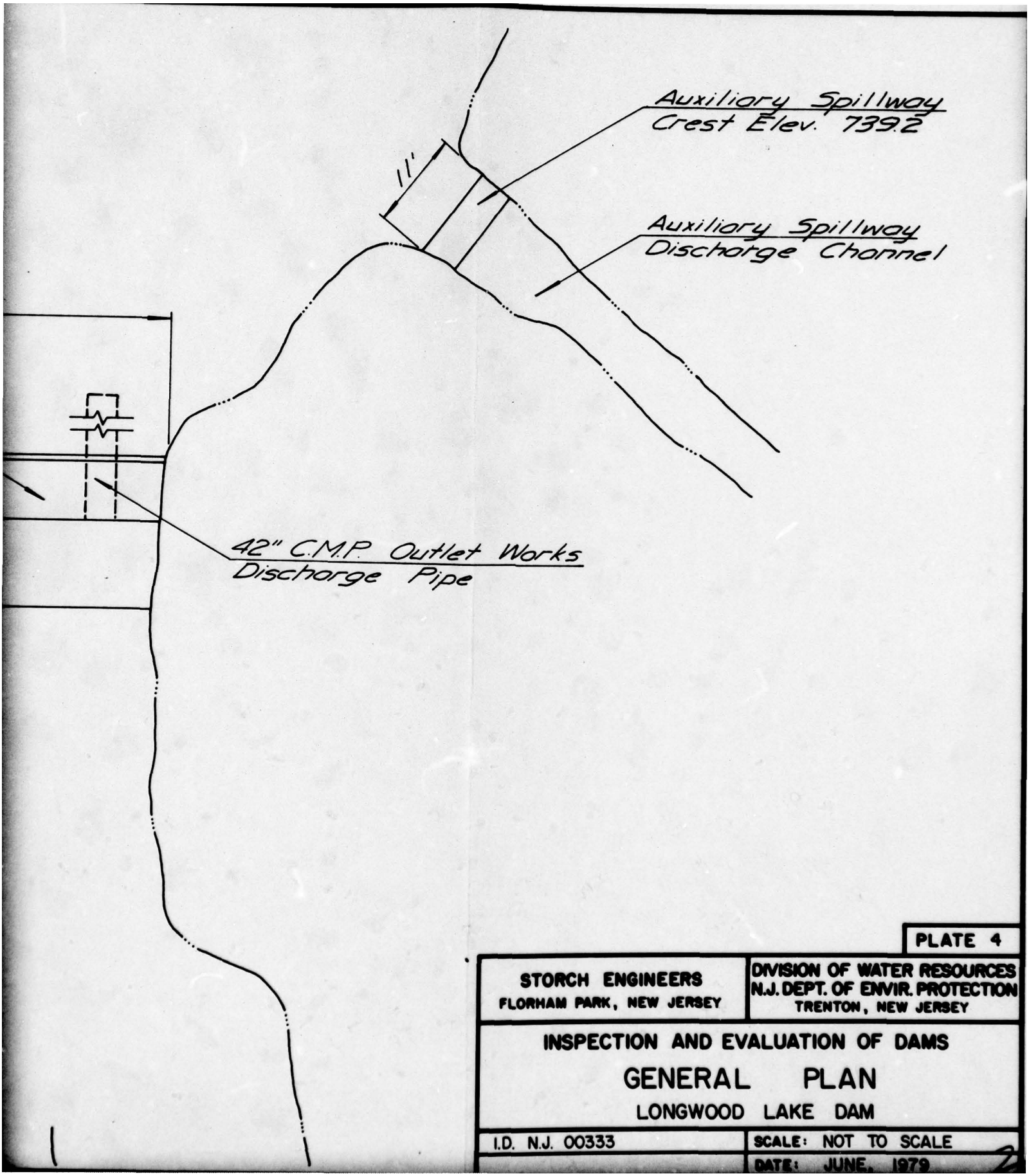


PLATE 4

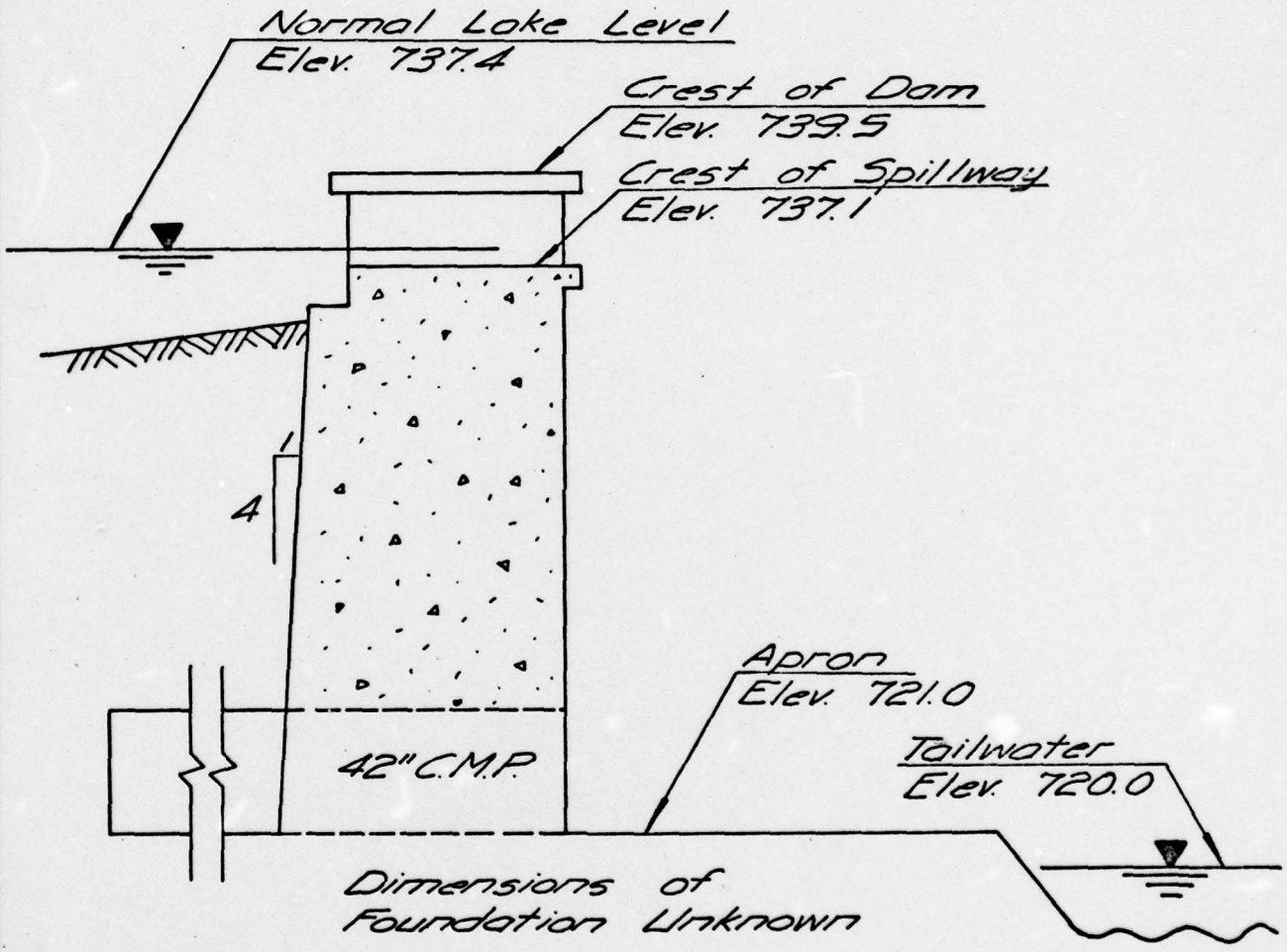
STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

GENERAL PLAN

LONGWOOD LAKE DAM

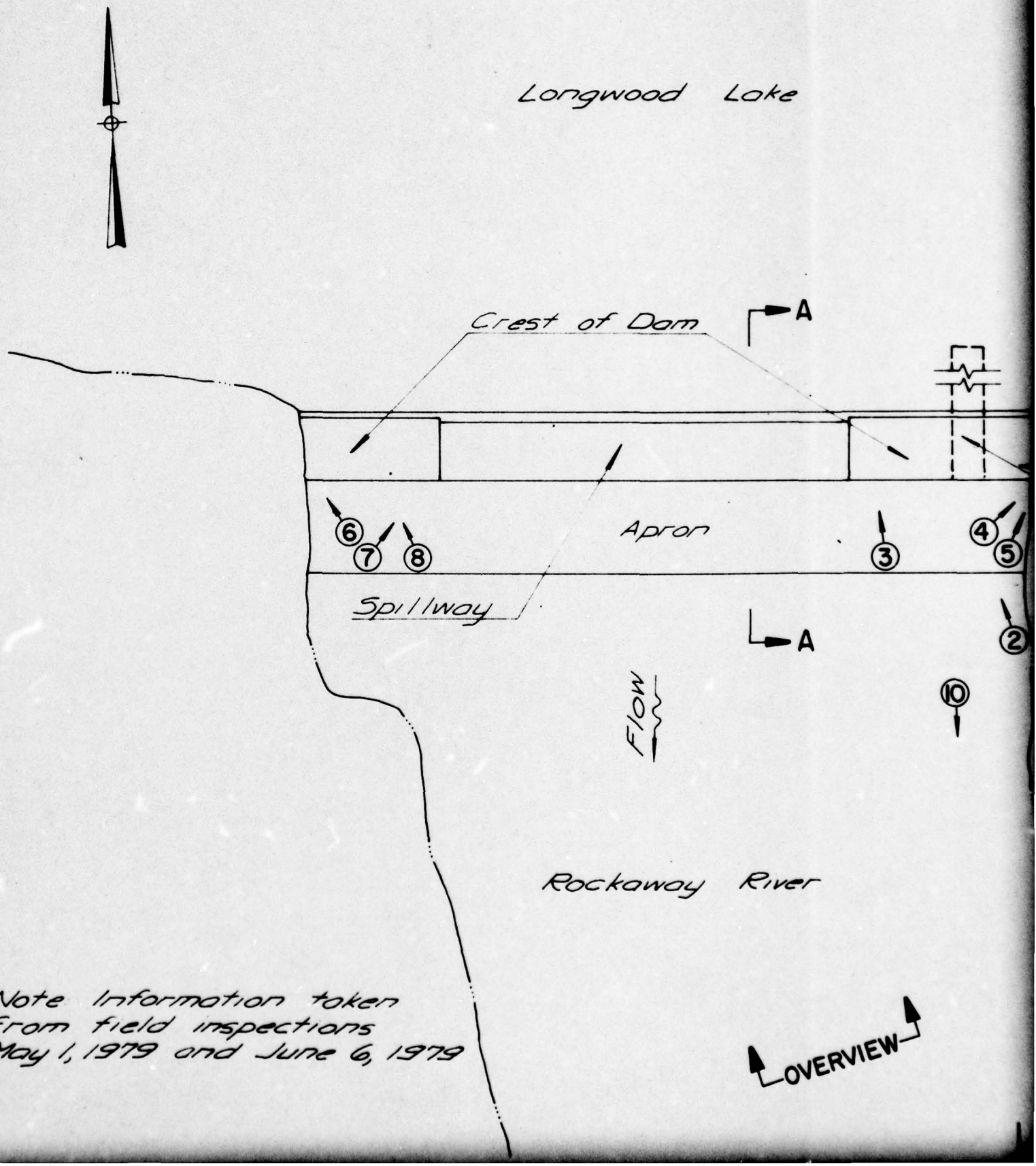
I.D. N.J. 00333	SCALE: NOT TO SCALE
	DATE: JUNE, 1979



Note: Information taken from field inspections May 1, 1979 and June 6, 1979.

PLATE 5

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	INSPECTION AND EVALUATION OF DAMS SECTION A-A LONGWOOD LAKE DAM
DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY	I.D. N.J. 00333 — SCALE: NOT TO SCALE DATE: JUNE, 1979



Note information taken from field inspections May 1, 1979 and June 6, 1979

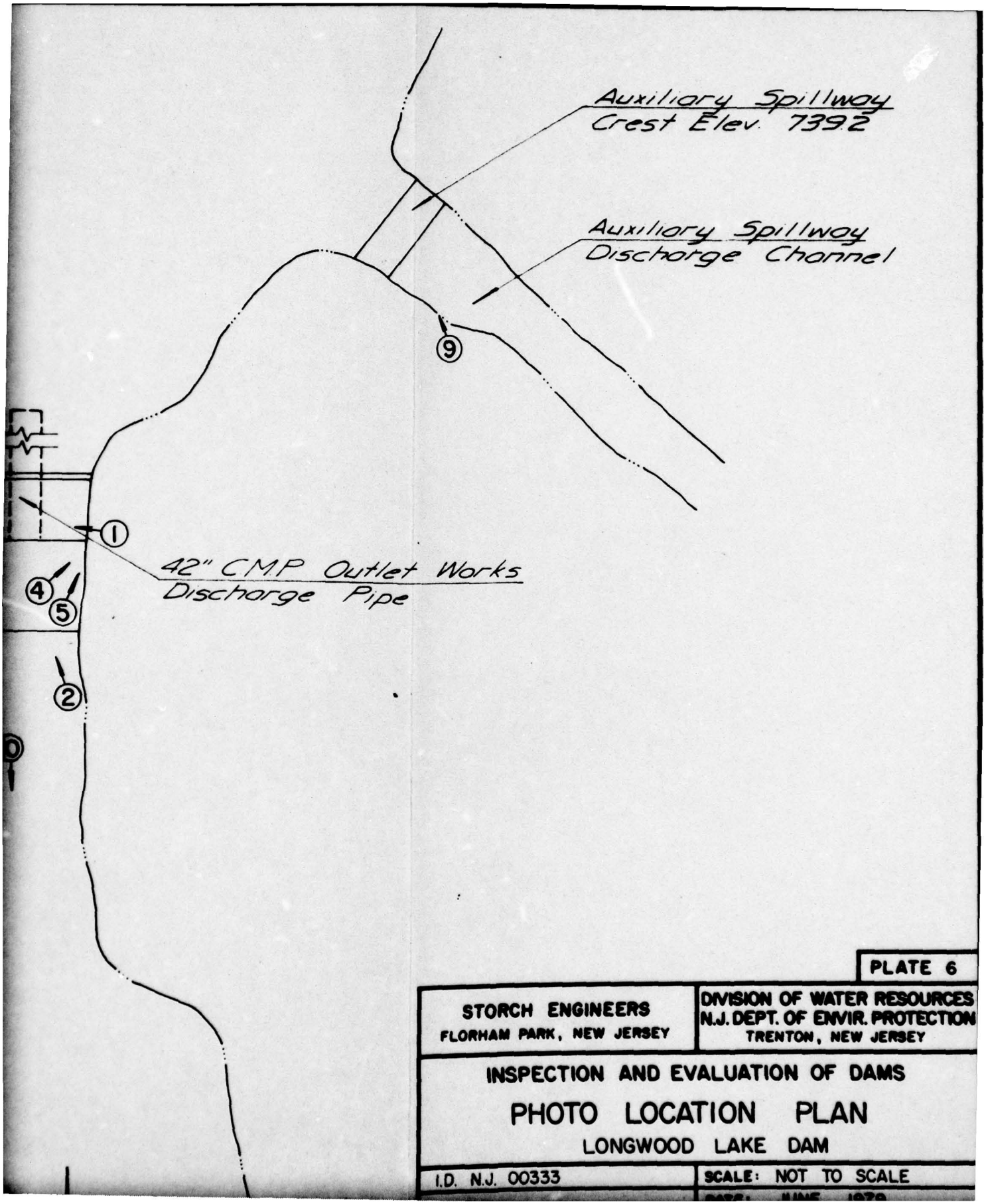


PLATE 6

STORCH ENGINEERS FLORHAM PARK, NEW JERSEY	DIVISION OF WATER RESOURCES N.J. DEPT. OF ENVIR. PROTECTION TRENTON, NEW JERSEY

INSPECTION AND EVALUATION OF DAMS

PHOTO LOCATION PLAN

LONGWOOD LAKE DAM

I.D. N.J. 00333	SCALE: NOT TO SCALE
	DATE: JUNE 1979

APPENDIX 1

Check List - Visual Inspection

Check List - Engineering Data

Check List
Visual Inspection
Phase I

Name of Dam Longwood Lake County Morris State New Jersey Coordinators NJDEP

Date(s) Inspection 5/1/79, 6/6/79 Weather Fair Temperature 70°F

Pool Elevation at Time of Inspection 737.4 M.S.L. Tailwater at Time of Inspection 720.0 M.S.L.

Inspection Personnel:

John Gribbin David Hoyt

Ronald Lai Joseph Fox

Richard McDermott

John Gribbin Recorder

Present: George Plastoris, Watershed Superintendent, City of Jersey City

CONCRETE/MASONRY DAMS

SUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
NERAL	Dam appeared to be outwardly structurally stable. Condition of crest generally satisfactory. Some spalling (approx. 3" deep) noted on downstream face of east and west sections.	
RUCTURE TO UTMENT/EMBANKMENT NCTIONS	Junctions appeared to be in generally satisfactory condition with evidence of some leakage.	Abutments at each end of dam consist of exposed bedrock.
AINS	None observed.	
RON	Several rocks are located on the apron which is obscured by discharge over the spillway.	
UNDATION	None observed	
RTICAL AND HORIZONTAL IGNMENT	Vertical: level Horizontal: straight	

CONCRETE/MASONRY DAMS

SUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RFACE CRACKS NCRETE SURFACES	Horizontal crack located along downstream face of dam approx. 1 foot below crest on east and west sections. Several minor cracks on downstream face with leaching noted.	It could not be determined whether these cracks are surface or structural.
RUCTURAL CRACKING	None observed	
NSTRUCTION JOINTS	None observed	
NOLITH JOINTS	N.A.	
EAKAGE	Leakage observed at some seams in exposed bedrock near east junction. Leakage discharge rate not measurable.	Recommend monitoring of leakage.
EEPAGE	Seepage observed at junctions between dam and natural abutments at each end of dam. Orange deposits noted. Seepage discharge rate not measurable.	Recommend monitoring of seepage.

EMBANKMENT

SUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
NERAL	N.A.	
NCTION OF EMBANKMENT D ABUTMENT, SPILLWAY D DAM	N.A.	
Y NOTICEABLE SEEPAGE	N.A.	
AFF GAGE AND RECORDER	N.A.	
AINS	N.A.	

EMBANKMENT

SUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
RFACE CRACKS	N.A.	
USUAL MOVEMENT OR ACKING AT OR BEYOND E TOE	N.A.	
OUGHING OR EROSION OF BANKMENT AND ABUTMENT OPES	N.A.	
RTICAL AND HORIZONTAL IGNMENT OF THE CREST	N.A.	
PRAP FAILURES	N.A.	

OUTLET WORKS

ISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ONCRETE SURFACES IN UTLET CONDUIT	N.A.	
NTAKE STRUCTURE	Submerged	
UTLET STRUCTURE	Outlet end of pipe was observed but was obscured by discharge. No significant distress was noted.	Outlet pipe consists of 42" C.M.P. near east end of dam.
UTLET CHANNEL	Same as spillway discharge channel.	
ATE AND GATE HOUSING	Metal cylinder protruding from center of spillway appeared to be gate operating stem. Gate could not be observed.	Gate not operated at time of inspection. Any connection between metal cylinder and 42" C.M.P. could not be determined.

SPILLWAY

ISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ENERAL	Weir appears to be in generally satisfactory condition. Vertical alignment is level and horizontal alignment is straight.	Spillway is overflow portion of dam.
PPROACH CHANNEL	N.A.	
ISCHARGE CHANNEL	Spillway discharges directly into downstream channel (Rockaway River).	
PRON	Same as apron for dam.	

AUXILIARY SPILLWAY

ISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ONCRETE WEIR	Weir appears to be level and in generally satisfactory condition.	Spillway consists of concrete dike constructed across low area of lake shore approx. 40' east of dam.
PPROACH CHANNEL	N.A.	
ISCHARGE CHANNEL	Narrow, well defined stream bed with steep sides composed of exposed bedrock.	
ENERAL	Upstream and downstream faces of spillway are vertical. Several minor cracks were observed in the concrete.	

INSTRUMENTATION

ISUAL EXAMINATION	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ONUMENTATION/SURVEYS	None	
BSERVATION WELLS	None	
EIRS	None	
PIEZOMETERS	None	
THER	N.A.	

RESERVOIR

ISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
LOPES	Shore slopes range from 5% to 20% with an average slope of approx. 10%.	
EDIMENTATION	Unknown.	
TRUCTURES ALONG ANKS	Many summer homes are located along the banks of the lake. Many home sites include docks and other lake related structures at the shoreline.	

DOWNSTREAM CHANNEL

ISUAL EXAMINATION OF	OBSERVATIONS	REMARKS OR RECOMMENDATIONS
ONDITION (OBSTRUCTIONS, DEBRIS, ETC.)	The downstream channel is wide, well defined river (Rockaway River) with no significant obstructions. In the vicinity of the dam it flows between nearly vertical outcroppings of bedrock. Approx. 250' downstream, the flood plain is wide and less steep.	
LOPES	Vicinity of dam: nearly vertical bank 250' Downstream: Approx. 8%	
TRUCTURES ALONG ANKS	No structures appear to be along the banks within 2 miles of the dam. A secondary road bridge crosses the stream approx. 2 miles from the dam.	

CHECK LIST
ENGINEERING DATA
DESIGN, CONSTRUCTION, OPERATION

EM	REMARKS
M - PLAN	Not Available
SECTIONS	Not Available
ILLWAY - PLAN	Not Available
SECTIONS	Not Available
DETAILS	Not Available
ERATING EQUIPMENT ANS & DETAILS	Not Available
TLETS - PLAN	Not Available
DETAILS	Not Available
CONSTRAINTS	Not Available
DISCHARGE RATINGS	Not Available
DRAULIC/HYDROLOGIC DATA	Not Available
INFALL/RESERVOIR RECORDS	Not Available
NSTRUCTION HISTORY	None Available
CATION MAP	Available, NJDEP file

ITEM	REMARKS
ESIGN REPORTS	Not Available
EOLOGY REPORTS	Not Available
ESIGN COMPUTATIONS HYDROLOGY & HYDRAULICS DAM STABILITY SEEPAGE STUDIES	Not Available
ATERIALS INVESTIGATIONS BORING RECORDS LABORATORY FIELD	Not Available
OST-CONSTRUCTION SURVEYS OF DAM	Not Available
ORROW SOURCES	None

ITEM	REMARKS
ONITORING SYSTEMS	A gauging weir operated by the City of Jersey City is located on the Rockaway River approximately 2 miles downstream from the dam. Reportedly, the City has kept gauging records since 1925.
ODIFICATIONS	Not Available
IGH POOL RECORDS	Not Available
OST CONSTRUCTION ENGINEERING TUDIES AND REPORTS	None Available
RIOR ACCIDENTS OR FAILURE OF DAM DESCRIPTION REPORTS	Not Available
AINTENANCE PERATION ECORDS	Available in NJDEP file (limited).

APPENDIX 2

Photographs

PHOTO 1

CREST OF DAM

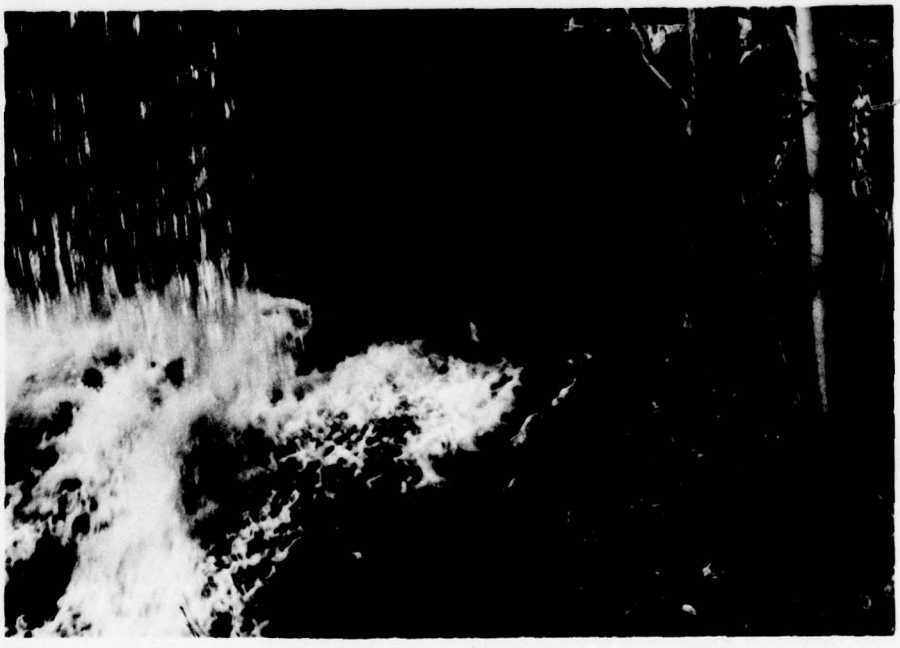


PHOTO 2

OUTLET WORKS DISCHARGE PIPE

LONGWOOD LAKE DAM
1 MAY 1979

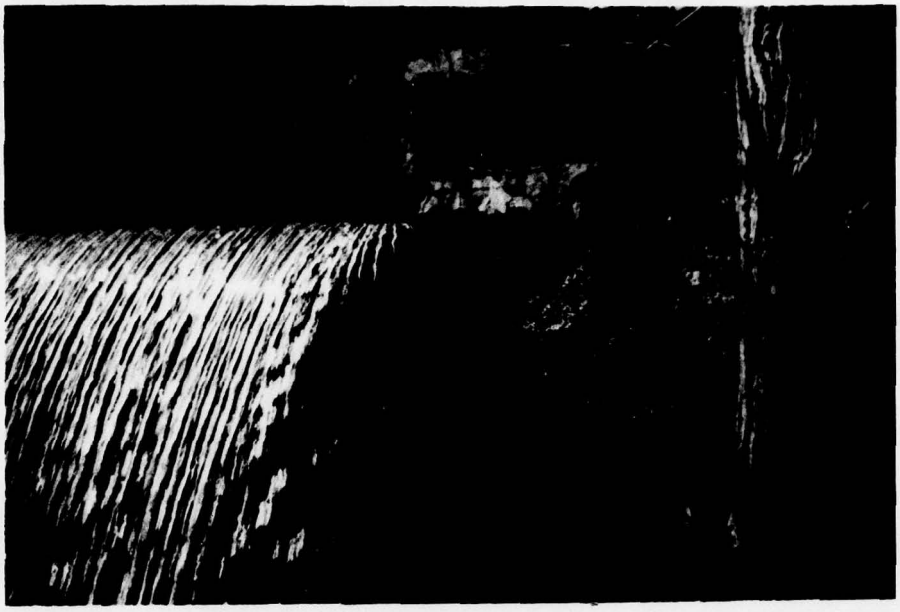


PHOTO 3

SPALL ON DOWNSTREAM FACE - EAST END OF DAM

PHOTO 4

JUNCTION BETWEEN EAST END OF DAM AND ROCK ABUTMENT

LONGWOOD LAKE DAM

1 MAY 1979

PHOTO 5

SEEPAGE AT EAST END OF DAM
1 MAY 1979

PHOTO 6

SEEPAGE AT WEST END OF DAM
6 JUNE 1979

PHOTO 7

SPALL ON DOWNSTREAM FACE - WEST END OF DAM

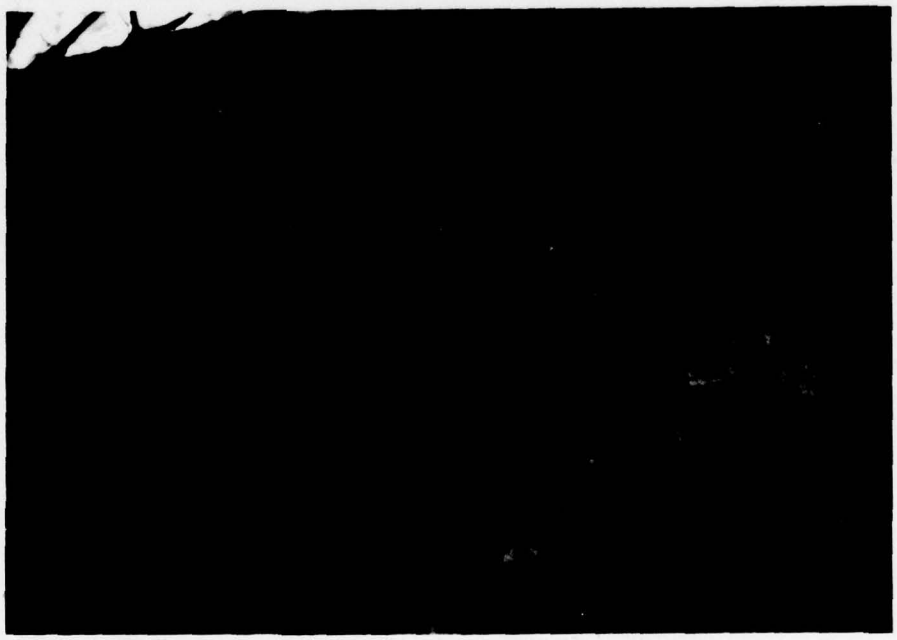


PHOTO 8

HORIZONTAL CRACK BELOW CREST OF WEST END OF DAM

LONGWOOD LAKE DAM

6 JUNE 1979

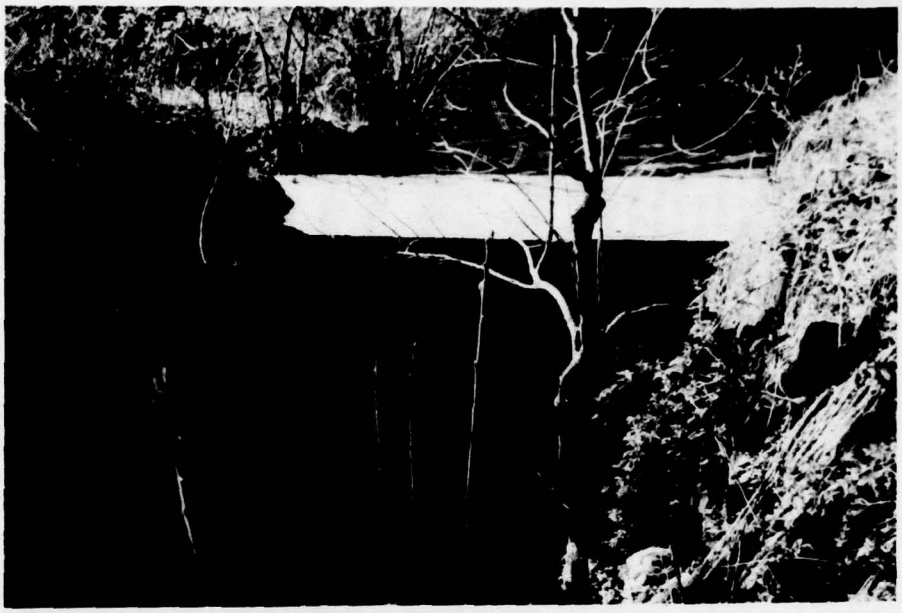


PHOTO 9

AUXILIARY SPILLWAY EAST OF DAM

PHOTO 10

DOWNSTREAM CHANNEL

LONGWOOD LAKE DAM
1 MAY 1979

APPENDIX 3

Engineering Data

CHECK LIST
HYDROLOGIC AND HYDRAULIC DATA
ENGINEERING DATA

DRAINAGE AREA CHARACTERISTICS: Mostly Wooded

ELEVATION TOP NORMAL POOL (STORAGE CAPACITY): 737.4 (214 acre-feet)

ELEVATION TOP FLOOD CONTROL POOL (STORAGE CAPACITY): N.A.

ELEVATION MAXIMUM DESIGN POOL: 744.7

ELEVATION TOP DAM: 739.5

PRINCIPAL SPILLWAY CREST: Concrete Weir

a. Elevation 737.1

b. Type Broad crested weir

c. Width 6 feet

d. Length 51 feet

e. Location Spillover Overflow portion of dam

f. Number and Type of Gates None

AUXILIARY SPILLWAY CREST: Concrete Weir

a. Elevation 739.2

b. Type Broad crested Weir

c. Width 5 feet

d. Length 11 feet

e. Location Spillover 40 feet east of dam

f. Number and Type of Gates None

OUTLET WORKS: Gated Pipe

a. Type 42-inch corrugated metal pipe

b. Location East end of dam

c. Entrance invert Unknown

d. Exit invert 721.0

e. Emergency draindown facilities: Adequacy of gate operating mechanism unknown

HYDROMETEOROLOGICAL GAGES: One gage

a. Type Weir

b. Location Across Rockaway River 2 miles downstream from dam

c. Records Unknown

MAXIMUM NON-DAMAGING DISCHARGE:

(Lake stage equal to top of dam) 577 c.f.s.

APPENDIX 4

Hydrologic Computations

STORCH ENGINEERS

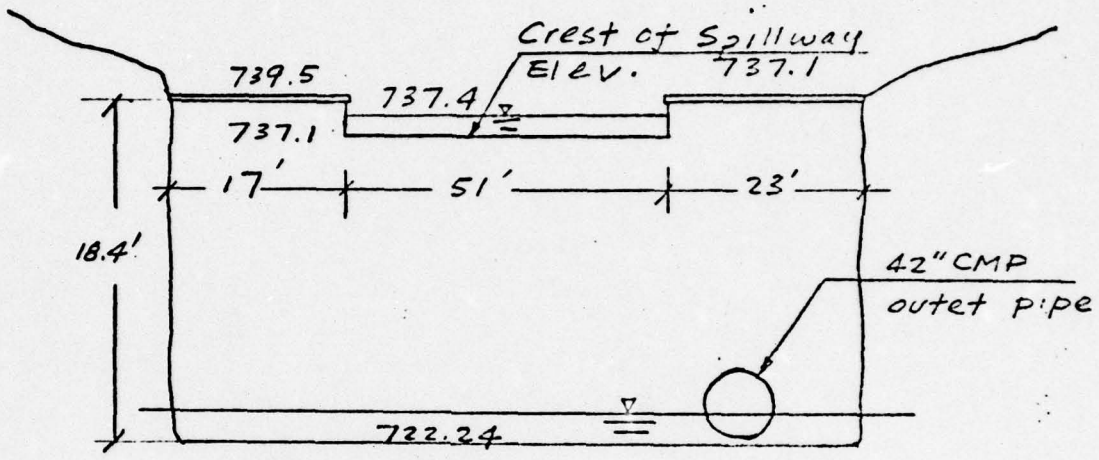
Sheet 1 of 7

Project Longwood Lake

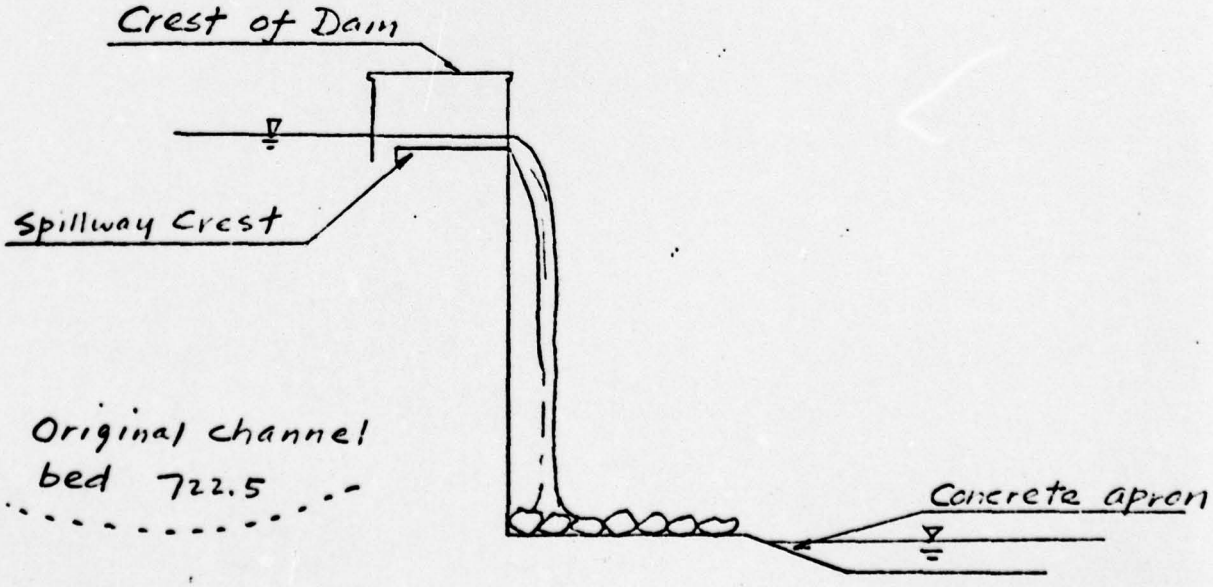
1132 B

Made By RL Date 7-9-79

Chkd By JG Date 7-11-79



Spillway Front Elevation



Spillway Section

HYDROLOGY

Hydrologic Analysis

Runoff hydrograph will be developed by HEC-1-DB using the Snyder coefficients as follows:

$C_t = 2.0$

$C_p = 0.62$

Drainage area 19 Sq mile

$L = 8.5$ mi

$L_{ca} = 3.4$ mi

$C_t = 2.0$

$$\text{Lag time}(t_p) = C_t (L L_{ca})^{0.3}$$

$$= 2 (8.5 \times 3.4)^{0.3}$$

$$= 5.48 \text{ hours}$$

∴ use 5.5 hours as lag time

and $C_p = 0.62$ for input

Precipitation

Rainfall Distribution for 100 year 24 hr. Storm will be calculated as follows:

From HYDRO-35

100 yr 1 hr. rainfall 3.0 in

From National Weather Service TP-40

100 yr 2 hr. rainfall 3.8 in

100 yr 3 hr rainfall 4.2 in

100 yr. 6 hr. rainfall 5.1 in

100 yr 12 hr. rainfall 6.2 in

100 yr 24 hr rainfall 7.2 in

24 Hr. Rainfall Distribution

Time (hr)	Rainfall (in)	Time (hr)	Rainfall (in)
1	0.06	13	0.30
2	0.08	14	0.30
3	0.08	15	0.60
4	0.08	16	3.00
5	0.06	17	0.40
6	0.08	18	0.30
7	0.09	19	0.19
8	0.09	20	0.18
9	0.18	21	0.09
10	0.18	22	0.09
11	0.15	23	0.08
12	0.19	24	0.08

Project Upper Longwood Lake Made By RL Date 7-10-79

Chkd By JG Date 7-11-79

Lake Elevation - Area

Elev.	722.5	737.4	740	760
Area (Ac.)	0	43	105	270

Infiltration Data

Drainage basin : Mostly wooded
Use 1.5 in. initial infiltration and 0.15 in/hr. constant infiltration

STORCH ENGINEERS Sheet 3 of 7

Project Longwood Lake Made By RL Date 7-10-75

1132 B Chkd By Date

HYDRAULICS

Spillway Length (effective) 50 ft

Head h_1

Discharge Coef 3.0

Auxiliary Spillway length 11 ft

Head h_2

Discharge Coef 3.0

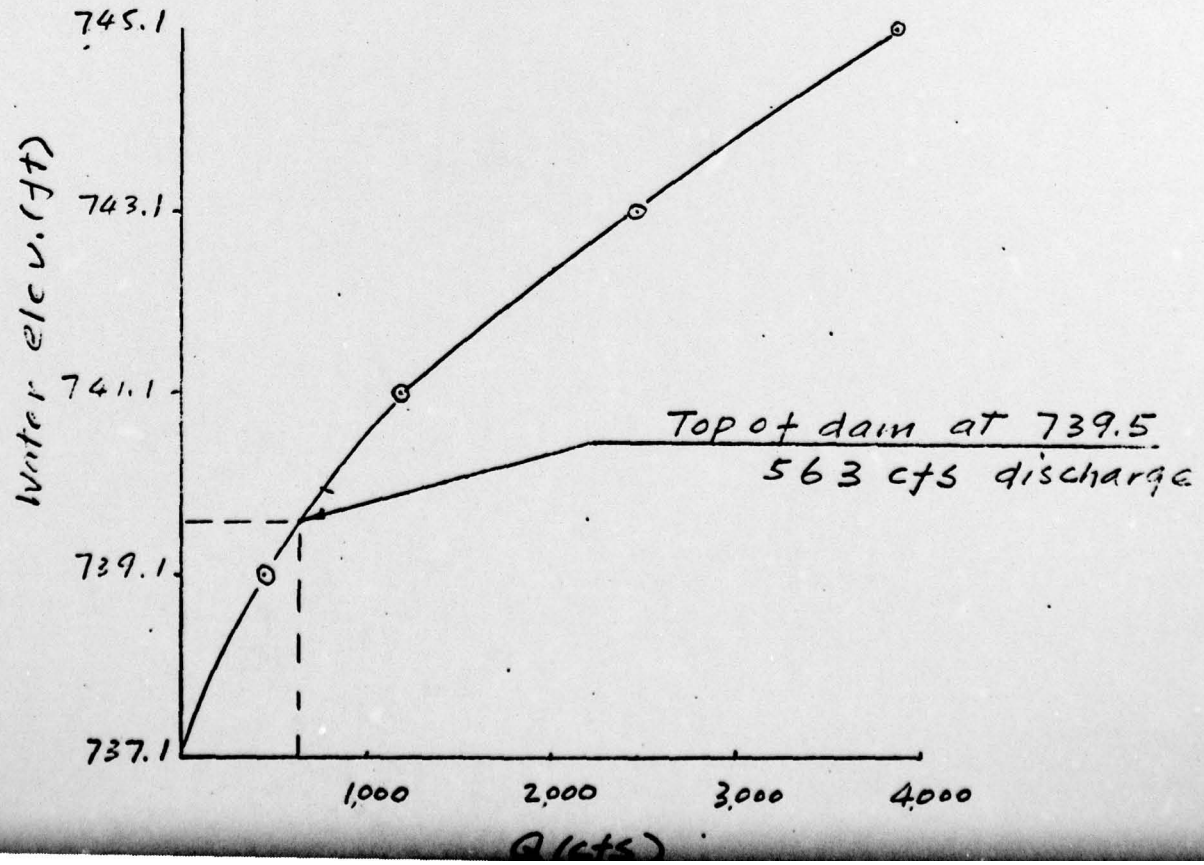
Discharge formula $Q = CLh^{1.5}$

Stage Discharge Tabulation

Water elev (ft)	h_1 (ft)	h_2 (ft)	Q_1 (cfs)	Q_2 (cfs)	Q Total (cfs)
737.1	0	0.	0	0	0
738.1	1	0	150	0	150
739.1	2	0	424	0	424
739.5	2.4	0.3	558	5	563
740.1	3	0.9	779	28	807
741.1	4	1.9	1200	86	1286
742.1	5	2.9	1677	163	1840
743.1	6	3.9	2205	254	2459
744.1	7	4.9	2778	358	3136
745.1	8	5.9	3394	473	3867

Spillway
Stage Discharge Curve

WL (ft)	Q (cfs)
737.1	0
739.1	424
739.5	563
741.1	1286
743.1	2459
745.1	3867



STORCH ENGINEERS

Sheet 7 of 7

Project Longwood Lake

Made By RL Date 8-13-79

Chkd By _____ Date _____

Outlet Works Capacity

42" CMP outlet pipe with inlet control

n = 0.012

Inflow = 1 cfs / sq mile

Total inflow to Longwood Lake = 19 cfs

Drawdown Calculation

1.9835 × (6)

Elev	Storage (Ac-ft)	Δ Storage (Ac-ft)	H (ft)	Q net (Q - 19)	Avg Q (cfs)	Ac-ft/day	Days
737.4	214		14.9	151			
		108			131	259.8	0.42
732.4	106		9.9	111			
		78			85	168.6	0.46
727.4	28		4.9	58			
		28			29	57.5	0.49
727.5	0		0	0.			

Total 1.37 days

Q values obtained from:

"Hydraulic Charts for the Selection of Highway Culverts" USDOT

HEC-1-DB COMPUTATIONS

```
A1                          NATIONAL DAM SAFETY PROGRAM
A2                    LONGWOOD LAKE DAM, NEW JERSEY.
A3                              100 YEAR STORM ROUTING.
B     150       1         0                                   0         0         3
B1      5
J       1       1         1
J1    1.0
K       0    LAKE                                 0         0         1         0
K1                SUBAREA RUNOFF FOR LONGWOOD LAKE
M       0       1        19                       19         1                   1
O      24       0
O1  0.08    0.08      0.08      0.08      0.08      0.08      0.08      0.09      0.09      0.18      0.18
O1  0.18    0.19      0.30      0.30      0.80      3.00      0.40      0.30      0.19      0.18
O1  0.09    0.09      0.08      0.08
T                                                           1.5       0.15
W     5.5   0.62
X    -1.0  -0.05       2.0
K       1     DAM                                 0         0         1
K1              ROUTE DISCHARGE THRU LONGWOOD LAKE DAM
Y                                       1         1
Y1      1                                                  -737.4      -1
Y4  737.1   738.1     739.1     740.1     741.1     742.1     743.1     744.1     745.1
Y5      0     150       424       807      1286      1840      2459      3136      3867
$A      0      43       105       270
$E  722.5   737.4       740       760
$$  737.1
$D  739.5     2.7       1.5        40
K      99
A
A
A
A
A
```

```
**********
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION     JULY 1978
  LAST MODIFICATION  26 FEB 79
**********

RUN  DATE= 79/07/10.
     TIME= 11.38.07.

                    NATIONAL DAM SAFETY PROGRAM
                LONGWOOD LAKE DAM, NEW JERSEY.
                      100 YEAR STORM ROUTING.

                          JOB SPECIFICATION
    NQ      NHR     NMIN     IDAY      IHR     IMIN    METRC     IPLT     IPRT    NSTAN
   150       1        0        0        0        0        0        0        3        0
                          JOPER      NWT    LROPT    TRACE
                             5        0        0        0

                    MULTI-PLAN ANALYSES TO BE PERFORMED
                        NPLAN= 1 NRTIO= 1 LRTIO= 1
          RTIOS=   1.00

**********          **********          **********          **********          **********

                        SUB-AREA RUNOFF COMPUTATION

          SUBAREA RUNOFF FOR LONGWOOD LAKE

                    ISTAQ   ICOMP   IECON   ITAPE    JPLT    JPRT   INAME  ISTAGE   IAUTO
                     LAKE       0       0       0       0       0       1       0       0

                              HYDROGRAPH DATA
          IHYDG     IUHG    TAREA     SNAP    TRSDA    TRSPC    RATIO    ISNOW    ISAME    LOCAL
              0        1    19.00     0.00    19.00     1.00    0.000        0        1        0

                              PRECIP DATA
                       NP    STORM      DAJ      DAK
                       24     0.00     0.00     0.00
                            PRECIP PATTERN
          .08      .08      .08      .08      .08      .08      .09      .09      .18      .18
          .18      .19      .30      .30      .80     3.00      .40      .30      .19      .18
          .09      .09      .08      .08

                              LOSS DATA
          LROPT   STRKR    DLTKR    RTIOL    ERAIN    STRKS    RTIOK    STRTL    CNSTL    ALSMX    RTIMP
              0    0.00     0.00     1.00     0.00     0.00     1.00     1.50      .15     0.00     0.00

                          UNIT HYDROGRAPH DATA
                        TP=  5.50    CP= .62    NTA=  0

                            RECESSION DATA
                    STRTQ=   -1.00    QRCSN=    -.05    RTIOR= 2.00
APPROXIMATE CLARK COEFFICIENTS FROM GIVEN SNYDER CP AND TP ARE TC= 6.32 AND R= 5.19 INTERVALS

     UNIT HYDROGRAPH 31 END-OF-PERIOD ORDINATES, LAG=  5.49 HOURS, CP=  .62  VOL= 1.00
      96.     350.     690.    1035.    1286.    1382.    1285.    1077.     888.     732.
     603.     497.     410.     338.     279.     230.     189.     156.     129.     106.
      87.      72.      59.      49.      40.      33.      27.      23.      19.      15.
      13.
```

END-OF-PERIOD FLOW

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.01	1.00	1	.08	0.00	.08	18.
1.01	2.00	2	.08	0.00	.08	17.
1.01	3.00	3	.08	0.00	.08	15.
1.01	4.00	4	.08	0.00	.08	14.
1.01	5.00	5	.08	0.00	.08	13.
1.01	6.00	6	.08	0.00	.08	13.
1.01	7.00	7	.09	0.00	.09	12.
1.01	8.00	8	.09	0.00	.09	11.
1.01	9.00	9	.18	0.00	.18	10.
1.01	10.00	10	.18	0.00	.18	9.
1.01	11.00	11	.18	0.00	.18	9.
1.01	12.00	12	.19	0.00	.19	8.
1.01	13.00	13	.30	.09	.21	17.
1.01	14.00	14	.30	.15	.15	55.
1.01	15.00	15	.80	.65	.15	187.
1.01	16.00	16	3.00	2.85	.15	708.
1.01	17.00	17	.40	.25	.15	1752.
1.01	18.00	18	.30	.15	.15	3070.
1.01	19.00	19	.19	.04	.15	4350.
1.01	20.00	20	.18	.03	.15	5243.
1.01	21.00	21	.09	0.00	.09	5539.
1.01	22.00	22	.09	0.00	.09	5169.
1.01	23.00	23	.08	0.00	.08	4428.
1.02	0.00	24	.08	0.00	.08	3703.
1.02	1.00	25	0.00	0.00	0.00	3071.
1.02	2.00	26	0.00	0.00	0.00	2537.
1.02	3.00	27	0.00	0.00	0.00	2092.
1.02	4.00	28	0.00	0.00	0.00	1725.
1.02	5.00	29	0.00	0.00	0.00	1423.
1.02	6.00	30	0.00	0.00	0.00	1173.
1.02	7.00	31	0.00	0.00	0.00	967.
1.02	8.00	32	0.00	0.00	0.00	798.
1.02	9.00	33	0.00	0.00	0.00	658.
1.02	10.00	34	0.00	0.00	0.00	543.
1.02	11.00	35	0.00	0.00	0.00	447.
1.02	12.00	36	0.00	0.00	0.00	369.
1.02	13.00	37	0.00	0.00	0.00	304.
1.02	14.00	38	0.00	0.00	0.00	268.
1.02	15.00	39	0.00	0.00	0.00	250.
1.02	16.00	40	0.00	0.00	0.00	233.
1.02	17.00	41	0.00	0.00	0.00	218.
1.02	18.00	42	0.00	0.00	0.00	203.
1.02	19.00	43	0.00	0.00	0.00	189.
1.02	20.00	44	0.00	0.00	0.00	177.
1.02	21.00	45	0.00	0.00	0.00	165.
1.02	22.00	46	0.00	0.00	0.00	154.
1.02	23.00	47	0.00	0.00	0.00	144.
1.03	0.00	48	0.00	0.00	0.00	134.
1.03	1.00	49	0.00	0.00	0.00	125.
1.03	2.00	50	0.00	0.00	0.00	117.
1.03	3.00	51	0.00	0.00	0.00	109.
1.03	4.00	52	0.00	0.00	0.00	102.
1.03	5.00	53	0.00	0.00	0.00	95.
1.03	6.00	54	0.00	0.00	0.00	88.
1.03	7.00	55	0.00	0.00	0.00	82.
1.03	8.00	56	0.00	0.00	0.00	77.
1.03	9.00	57	0.00	0.00	0.00	72.
1.03	10.00	58	0.00	0.00	0.00	67.
1.03	11.00	59	0.00	0.00	0.00	63.
1.03	12.00	60	0.00	0.00	0.00	58.
1.03	13.00	61	0.00	0.00	0.00	54.
1.03	14.00	62	0.00	0.00	0.00	51.
1.03	15.00	63	0.00	0.00	0.00	47.
1.03	16.00	64	0.00	0.00	0.00	44.
1.03	17.00	65	0.00	0.00	0.00	41.
1.03	18.00	66	0.00	0.00	0.00	38.
1.03	19.00	67	0.00	0.00	0.00	36.
1.03	20.00	68	0.00	0.00	0.00	33.
1.03	21.00	69	0.00	0.00	0.00	31.
1.03	22.00	70	0.00	0.00	0.00	29.
1.03	23.00	71	0.00	0.00	0.00	27.
1.04	0.00	72	0.00	0.00	0.00	25.
1.04	1.00	73	0.00	0.00	0.00	24.
1.04	2.00	74	0.00	0.00	0.00	22.
1.04	3.00	75	0.00	0.00	0.00	21.

MO.DA	HR.MN	PERIOD	RAIN	EXCS	LOSS	COMP Q
1.04	4.00	76	0.00	0.00	0.00	19.
1.04	5.00	77	0.00	0.00	0.00	18.
1.04	6.00	78	0.00	0.00	0.00	17.
1.04	7.00	79	0.00	0.00	0.00	16.
1.04	8.00	80	0.00	0.00	0.00	15.
1.04	9.00	81	0.00	0.00	0.00	14.
1.04	10.00	82	0.00	0.00	0.00	13.
1.04	11.00	83	0.00	0.00	0.00	12.
1.04	12.00	84	0.00	0.00	0.00	11.
1.04	13.00	85	0.00	0.00	0.00	10.
1.04	14.00	86	0.00	0.00	0.00	10.
1.04	15.00	87	0.00	0.00	0.00	9.
1.04	16.00	88	0.00	0.00	0.00	8.
1.04	17.00	89	0.00	0.00	0.00	8.
1.04	18.00	90	0.00	0.00	0.00	7.
1.04	19.00	91	0.00	0.00	0.00	7.
1.04	20.00	92	0.00	0.00	0.00	6.
1.04	21.00	93	0.00	0.00	0.00	6.
1.04	22.00	94	0.00	0.00	0.00	6.
1.04	23.00	95	0.00	0.00	0.00	5.
1.05	0.00	96	0.00	0.00	0.00	5.
1.05	1.00	97	0.00	0.00	0.00	4.
1.05	2.00	98	0.00	0.00	0.00	4.
1.05	3.00	99	0.00	0.00	0.00	4.
1.05	4.00	100	0.00	0.00	0.00	4.
1.05	5.00	101	0.00	0.00	0.00	3.
1.05	6.00	102	0.00	0.00	0.00	3.
1.05	7.00	103	0.00	0.00	0.00	3.
1.05	8.00	104	0.00	0.00	0.00	3.
1.05	9.00	105	0.00	0.00	0.00	3.
1.05	10.00	106	0.00	0.00	0.00	2.
1.05	11.00	107	0.00	0.00	0.00	2.
1.05	12.00	108	0.00	0.00	0.00	2.
1.05	13.00	109	0.00	0.00	0.00	2.
1.05	14.00	110	0.00	0.00	0.00	2.
1.05	15.00	111	0.00	0.00	0.00	2.
1.05	16.00	112	0.00	0.00	0.00	2.
1.05	17.00	113	0.00	0.00	0.00	1.
1.05	18.00	114	0.00	0.00	0.00	1.
1.05	19.00	115	0.00	0.00	0.00	1.
1.05	20.00	116	0.00	0.00	0.00	1.
1.05	21.00	117	0.00	0.00	0.00	1.
1.05	22.00	118	0.00	0.00	0.00	1.
1.05	23.00	119	0.00	0.00	0.00	1.
1.06	0.00	120	0.00	0.00	0.00	1.
1.06	1.00	121	0.00	0.00	0.00	1.
1.06	2.00	122	0.00	0.00	0.00	1.
1.06	3.00	123	0.00	0.00	0.00	1.
1.06	4.00	124	0.00	0.00	0.00	1.
1.06	5.00	125	0.00	0.00	0.00	1.
1.06	6.00	126	0.00	0.00	0.00	1.
1.06	7.00	127	0.00	0.00	0.00	1.
1.06	8.00	128	0.00	0.00	0.00	1.
1.06	9.00	129	0.00	0.00	0.00	0.
1.06	10.00	130	0.00	0.00	0.00	0.
1.06	11.00	131	0.00	0.00	0.00	0.
1.06	12.00	132	0.00	0.00	0.00	0.
1.06	13.00	133	0.00	0.00	0.00	0.
1.06	14.00	134	0.00	0.00	0.00	0.
1.06	15.00	135	0.00	0.00	0.00	0.
1.06	16.00	136	0.00	0.00	0.00	0.
1.06	17.00	137	0.00	0.00	0.00	0.
1.06	18.00	138	0.00	0.00	0.00	0.
1.06	19.00	139	0.00	0.00	0.00	0.
1.06	20.00	140	0.00	0.00	0.00	0.
1.06	21.00	141	0.00	0.00	0.00	0.
1.06	22.00	142	0.00	0.00	0.00	0.
1.06	23.00	143	0.00	0.00	0.00	0.
1.07	0.00	144	0.00	0.00	0.00	0.
1.07	1.00	145	0.00	0.00	0.00	0.
1.07	2.00	146	0.00	0.00	0.00	0.
1.07	3.00	147	0.00	0.00	0.00	0.
1.07	4.00	148	0.00	0.00	0.00	0.
1.07	5.00	149	0.00	0.00	0.00	0.
1.07	6.00	150	0.00	0.00	0.00	0.
		SUM	7.20	4.22	2.98	54473.
			(183.)(	107.)(	76.)(	1542.50)

DAM DATA

TOPEL	COQD	EXPD	DAMWID
739.5	2.7	1.5	40.

STATION DAM, PLAN 1, RATIO 1

END-OF-PERIOD HYDROGRAPH ORDINATES

MO.DA	HR.MN	PERIOD	HOURS	INFLOW	OUTFLOW	STORAGE	STAGE
1.01	1.00	1	1.00	18.	38.	212.	737.4
1.01	2.00	2	2.00	17.	33.	210.	737.3
1.01	3.00	3	3.00	15.	29.	209.	737.3
1.01	4.00	4	4.00	14.	25.	208.	737.3
1.01	5.00	5	5.00	13.	22.	207.	737.2
1.01	6.00	6	6.00	13.	20.	206.	737.2
1.01	7.00	7	7.00	12.	18.	206.	737.2
1.01	8.00	8	8.00	11.	16.	205.	737.2
1.01	9.00	9	9.00	10.	15.	205.	737.2
1.01	10.00	10	10.00	9.	14.	205.	737.2
1.01	11.00	11	11.00	9.	12.	204.	737.2
1.01	12.00	12	12.00	8.	11.	204.	737.2
1.01	13.00	13	13.00	17.	12.	204.	737.2
1.01	14.00	14	14.00	55.	18.	206.	737.2
1.01	15.00	15	15.00	187.	44.	213.	737.4
1.01	16.00	16	16.00	708.	135.	243.	738.0
1.01	17.00	17	17.00	1752.	442.	321.	739.1
1.01	18.00	18	18.00	3070.	1119.	455.	740.5
1.01	19.00	19	19.00	4350.	2219.	624.	742.0
1.01	20.00	20	20.00	5243.	3432.	787.	743.3
1.01	21.00	21	21.00	5539.	4391.	909.	744.3
1.01	22.00	22	22.00	5169.	4872.	969.	744.7
1.01	23.00	23	23.00	4428.	4835.	964.	744.7
1.02	0.00	24	24.00	3703.	4450.	917.	744.3
1.02	1.00	25	25.00	3071.	3926.	850.	743.8
1.02	2.00	26	26.00	2537.	3379.	780.	743.3
1.02	3.00	27	27.00	2092.	2873.	713.	742.7
1.02	4.00	28	28.00	1725.	2421.	652.	742.2
1.02	5.00	29	29.00	1423.	2040.	598.	741.8
1.02	6.00	30	30.00	1173.	1713.	550.	741.4
1.02	7.00	31	31.00	967.	1437.	508.	741.0
1.02	8.00	32	32.00	798.	1216.	472.	740.7
1.02	9.00	33	33.00	658.	1024.	439.	740.4
1.02	10.00	34	34.00	543.	860.	411.	740.1
1.02	11.00	35	35.00	447.	740.	386.	739.9
1.02	12.00	36	36.00	369.	631.	363.	739.6
1.02	13.00	37	37.00	304.	540.	342.	739.4
1.02	14.00	38	38.00	268.	461.	325.	739.2
1.02	15.00	39	39.00	250.	402.	310.	739.0
1.02	16.00	40	40.00	233.	361.	299.	738.9
1.02	17.00	41	41.00	218.	324.	289.	738.7
1.02	18.00	42	42.00	203.	293.	281.	738.6
1.02	19.00	43	43.00	189.	265.	274.	738.5
1.02	20.00	44	44.00	177.	241.	269.	738.4
1.02	21.00	45	45.00	165.	220.	264.	738.4
1.02	22.00	46	46.00	154.	201.	259.	738.3
1.02	23.00	47	47.00	144.	184.	256.	738.2
1.03	0.00	48	48.00	134.	170.	253.	738.2
1.03	1.00	49	49.00	125.	157.	250.	738.1
1.03	2.00	50	50.00	117.	147.	247.	738.1
1.03	3.00	51	51.00	109.	140.	245.	738.0
1.03	4.00	52	52.00	102.	133.	242.	738.0
1.03	5.00	53	53.00	95.	126.	240.	737.9
1.03	6.00	54	54.00	88.	119.	237.	737.9
1.03	7.00	55	55.00	82.	112.	235.	737.8
1.03	8.00	56	56.00	77.	105.	232.	737.8
1.03	9.00	57	57.00	72.	98.	230.	737.8
1.03	10.00	58	58.00	67.	92.	228.	737.7
1.03	11.00	59	59.00	63.	86.	226.	737.7
1.03	12.00	60	60.00	58.	80.	224.	737.6
1.03	13.00	61	61.00	54.	74.	222.	737.6
1.03	14.00	62	62.00	51.	69.	221.	737.6
1.03	15.00	63	63.00	47.	64.	219.	737.5
1.03	16.00	64	64.00	44.	60.	218.	737.5
1.03	17.00	65	65.00	41.	56.	217.	737.5
1.03	18.00	66	66.00	38.	52.	216.	737.4
1.03	19.00	67	67.00	36.	49.	215.	737.4
1.03	20.00	68	68.00	33.	45.	214.	737.4
1.03	21.00	69	69.00	31.	42.	213.	737.4
1.03	22.00	70	70.00	29.	39.	212.	737.4
1.03	23.00	71	71.00	27.	37.	211.	737.3
1.04	0.00	72	72.00	25.	34.	210.	737.3
1.04	1.00	73	73.00	24.	32.	210.	737.3
1.04	2.00	74	74.00	22.	29.	209.	737.3
1.04	3.00	75	75.00	21.	27.	209.	737.3
1.04	4.00	76	76.00	19.	26.	208.	737.3
1.04	5.00	77	77.00	18.	24.	208.	737.3
1.04	6.00	78	78.00	17.	22.	207.	737.2

END-OF-PERIOD HYDROGRAPH ORDINATES

MO.DA	HR.MN	PERIOD	HOURS	INFLOW	OUTFLOW	STORAGE	STAGE
1.04	7.00	79	79.00	16.	21.	207.	737.2
1.04	8.00	80	80.00	15.	19.	206.	737.2
1.04	9.00	81	81.00	14.	18.	206.	737.2
1.04	10.00	82	82.00	13.	17.	206.	737.2
1.04	11.00	83	83.00	12.	16.	205.	737.2
1.04	12.00	84	84.00	11.	15.	205.	737.2
1.04	13.00	85	85.00	10.	14.	205.	737.2
1.04	14.00	86	86.00	10.	13.	204.	737.2
1.04	15.00	87	87.00	9.	12.	204.	737.2
1.04	16.00	88	88.00	8.	11.	204.	737.2
1.04	17.00	89	89.00	8.	10.	204.	737.2
1.04	18.00	90	90.00	7.	10.	204.	737.2
1.04	19.00	91	91.00	7.	9.	203.	737.2
1.04	20.00	92	92.00	6.	8.	203.	737.2
1.04	21.00	93	93.00	6.	8.	203.	737.2
1.04	22.00	94	94.00	6.	7.	203.	737.1
1.04	23.00	95	95.00	5.	7.	203.	737.1
1.05	0.00	96	96.00	5.	6.	203.	737.1
1.05	1.00	97	97.00	4.	6.	203.	737.1
1.05	2.00	98	98.00	4.	5.	202.	737.1
1.05	3.00	99	99.00	4.	5.	202.	737.1
1.05	4.00	100	100.00	4.	5.	202.	737.1
1.05	5.00	101	101.00	3.	4.	202.	737.1
1.05	6.00	102	102.00	3.	4.	202.	737.1
1.05	7.00	103	103.00	3.	4.	202.	737.1
1.05	8.00	104	104.00	3.	4.	202.	737.1
1.05	9.00	105	105.00	3.	3.	202.	737.1
1.05	10.00	106	106.00	2.	3.	202.	737.1
1.05	11.00	107	107.00	2.	3.	202.	737.1
1.05	12.00	108	108.00	2.	3.	202.	737.1
1.05	13.00	109	109.00	2.	3.	202.	737.1
1.05	14.00	110	110.00	2.	2.	202.	737.1
1.05	15.00	111	111.00	2.	2.	202.	737.1
1.05	16.00	112	112.00	2.	2.	201.	737.1
1.05	17.00	113	113.00	1.	2.	201.	737.1
1.05	18.00	114	114.00	1.	2.	201.	737.1
1.05	19.00	115	115.00	1.	2.	201.	737.1
1.05	20.00	116	116.00	1.	2.	201.	737.1
1.05	21.00	117	117.00	1.	1.	201.	737.1
1.05	22.00	118	118.00	1.	1.	201.	737.1
1.05	23.00	119	119.00	1.	1.	201.	737.1
1.06	0.00	120	120.00	1.	1.	201.	737.1
1.06	1.00	121	121.00	1.	1.	201.	737.1
1.06	2.00	122	122.00	1.	1.	201.	737.1
1.06	3.00	123	123.00	1.	1.	201.	737.1
1.06	4.00	124	124.00	1.	1.	201.	737.1
1.06	5.00	125	125.00	1.	1.	201.	737.1
1.06	6.00	126	126.00	1.	1.	201.	737.1
1.06	7.00	127	127.00	1.	1.	201.	737.1
1.06	8.00	128	128.00	1.	1.	201.	737.1
1.06	9.00	129	129.00	0.	1.	201.	737.1
1.06	10.00	130	130.00	0.	1.	201.	737.1
1.06	11.00	131	131.00	0.	1.	201.	737.1
1.06	12.00	132	132.00	0.	1.	201.	737.1
1.06	13.00	133	133.00	0.	0.	201.	737.1
1.06	14.00	134	134.00	0.	0.	201.	737.1
1.06	15.00	135	135.00	0.	0.	201.	737.1
1.06	16.00	136	136.00	0.	0.	201.	737.1
1.06	17.00	137	137.00	0.	0.	201.	737.1
1.06	18.00	138	138.00	0.	0.	201.	737.1
1.06	19.00	139	139.00	0.	0.	201.	737.1
1.06	20.00	140	140.00	0.	0.	201.	737.1
1.06	21.00	141	141.00	0.	0.	201.	737.1
1.06	22.00	142	142.00	0.	0.	201.	737.1
1.06	23.00	143	143.00	0.	0.	201.	737.1
1.07	0.00	144	144.00	0.	0.	201.	737.1
1.07	1.00	145	145.00	0.	0.	201.	737.1
1.07	2.00	146	146.00	0.	0.	201.	737.1
1.07	3.00	147	147.00	0.	0.	201.	737.1
1.07	4.00	148	148.00	0.	0.	201.	737.1
1.07	5.00	149	149.00	0.	0.	201.	737.1
1.07	6.00	150	150.00	0.	0.	201.	737.1

PEAK OUTFLOW IS 4872. AT TIME 22.00 HOURS

SUMMARY OF DAM SAFETY ANALYSIS

.....		INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
	ELEVATION	737.40	737.10	739.50
	STORAGE	214.	201.	351.
	OUTFLOW	45.	0.	577.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
1.00	744.72	5.22	969.	4872.	19.00	22.00	0.00

APPENDIX 5

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